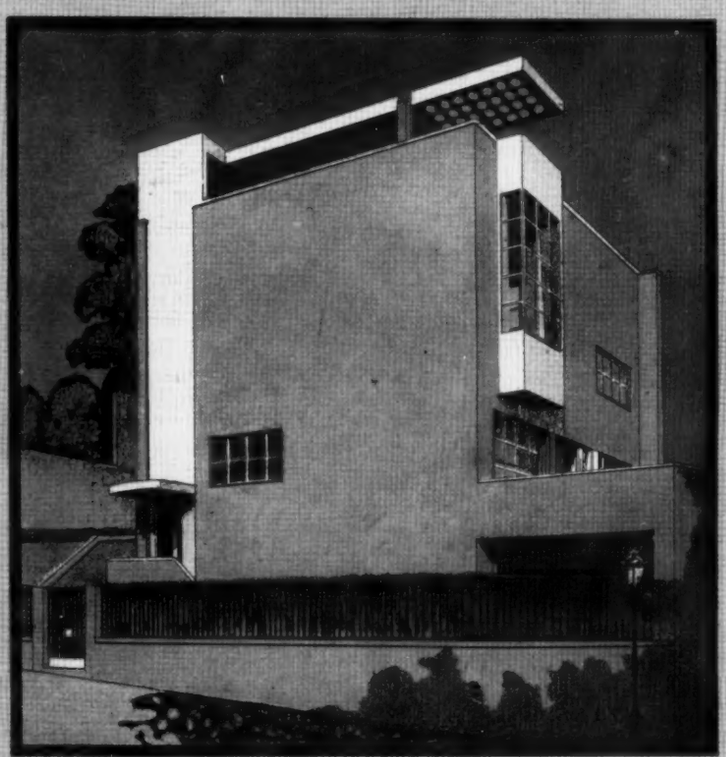
THE ARCHITECTURAL FORUM

OCT 12 1929

IN TWO PARTS



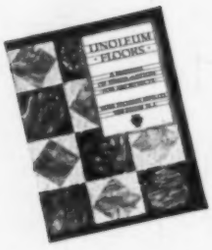
PART ONE
ARCHITECTURAL DESIGN

OCTOBER

1929

Interior of Southwestern Bell Telephone Company Building at Fort Worth, Texas. Double-Waxed *Linoleum, made by W. & J. Sloane. Photograph un-retouched.*

Linoleum delivered to job with DOUBLE-WAX FINISH



This Service Free to Architects

If you wish practical suggestions in planning linoleum floors, do not hesitate to call upon our Architects Service Department. There is no charge nor obligation involved. You may also have for the asking a copy of the Linoleum Data Book illustrated above. It will help you in preparing specifications. Address: Architects Service Department, W. & J. Sloane, 577 Fifth Avenue, New York City.

MANY specifications now call for linoleum to be delivered to the job with the wax finish already applied.

For years waxing has been recognized as the one suitable treatment for the preservation of linoleum floors. The wax forms a surface film which prevents dirt and grime from being ground into the body of the linoleum. This both enhances the appearance by giving a pleasing lustre to the floor and decreases the amount of cleaning and care required.

The exceptional finish of W. & J. Sloane Linoleum comes first from extra-processing in manufacture. This provides a smooth, compact surface without pores or cracks. To this fine *natural* finish is then added a double coat of wax applied *at the plant.*

W. & J. Sloane *Double-Waxed* Linoleum meets with approval on big jobs because it is easy to handle and lay and ready for instant use when laid.

Look carefully into the matter of finish before you specify. We will gladly send you quality samples for comparison.

W. & J. SLOANE
Double-Waxed LINOLEUM

THE EDITOR'S FORUM

OLD TAPESTRY IN BOSTON MUSEUM

THROUGH the generosity of Robert Treat Paine, 2nd, the Boston Museum of Fine Arts has lately been enriched by a splendid example of late fifteenth century tapestry. While abroad this summer, Mr. Paine purchased the tapestry from Knole House, in Kent, probably the most perfect surviving example of domestic architecture of Tudor England. For more than 400 years the tapestry has hung in the chapel of this famous baronial residence, having been brought to Knole early in the sixteenth century by Archbishop Wareham, then its owner. Like all great houses of early England, Knole House was built in successive stages. Since 1586 it has been in possession of the Sackville family, to whom it passed through gift by Queen Elizabeth to her cousin, Thomas Sackville. According to tradition there are seven courts, 52 staircases, and 365 rooms, the rooms with the exception of the great halls, being small, hospitable, and essentially livable.

The splendid Gothic tapestry, which has after so many centuries left this house for the Boston Museum, measures 29 feet long and 13 feet high. It was woven about 1490, possibly for a cathedral, from which it may have passed into the hands of Archbishop Wareham. This seems possible, since the composition of the tapestry is such as to suggest that the original design included other scenes which may have been cut off at the time the tapestry was installed at Knole between the years of 1503 and 1532, when Archbishop Wareham was in residence there. In the tapestry there are represented six scenes from the Passion depicting the trial and suffering of Christ at the hands of Pilate, Herod, and the populace on the day of the crucifixion. The figures are clad in mediæval costumes of the closing years of the fifteenth century, and each scene is framed in a contemporary architectural design. That the tapestry is from the hand of a very great designer is evident from the drawing and arrangement of the several parts as well from the splendid unified ensemble. While the artist is as yet unidentified, a clue exists in the similarity of the designs of this tapestry and those of the more fragmentary Passion tapestry of St. Maurice, Angers, which is attributed to the much discussed designer, Jean van Roome, and to the no less celebrated Brussels weaver, Pieter van Aelst.

Comparatively few great religious tapestries have survived from so early a date as the Knole tapestry, but many were doubtless woven for cathedrals and chapels, just as many historical and allegorical tapestries were woven for the great halls, and domestic and intimate hangings produced for the retiring rooms of the mediæval houses. The Knole tapestry is one of the great hangings surviving from the Gothic period. It comes to the Boston Museum in an unusually fine state of preservation, with no patching and practically no darning. Its beautiful colors, quite characteristic of Gothic weavings of the late fifteenth century, are rich and uniformly faded.

THE INSTITUTE STUDIES PLAYGROUNDS

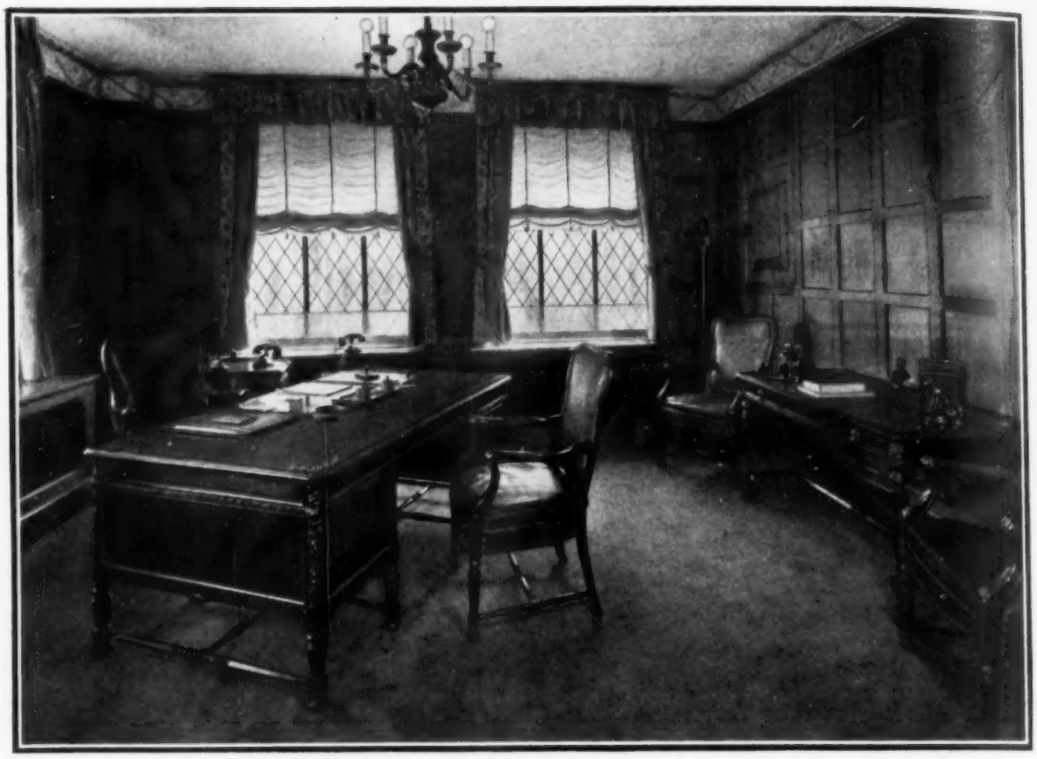
THE American Institute of Architects, through its City and Regional Planning Committee, announces the formulation of plans for aiding the improvement and maintenance of school playgrounds. Charles H. Cheney, the chairman of the Committee, says: "The cost of maintaining playgrounds is a problem which most cities find difficult. Development of playgrounds might naturally be expected of the school boards, which have the responsibility of training the children's minds, and which, in some states, at least, must also provide them with physical education; but in no city are school budgets sufficient to do the playground work necessary outside of school hours or to keep playgrounds open in summer. Hence it is common practice for cities to have a separate playground department for play activities. Sometimes this department is placed under the park board, and sometimes under a separate playground commission. To carry on its work, the budget of the city council provides as much or even more money than the physical education department of the school budget.

"As these play activities of both city department and school department are for children in the same neighborhood, it is decidedly uneconomical to provide separate playgrounds, toilets and field houses for the city department when school buildings, toilets and school grounds already exist. In recent years a coöperative plan between the city council and the school board has been worked out in a considerable number of cities, whereby they join together, each paying half the expense of a good superintendent of playgrounds and physical education combined. He organizes the physical training in the schools, during school hours, and supervises playgrounds outside of school hours, and on holidays, Sundays and vacations throughout the year.

"Oakland, California, has developed the most efficient system along this line in the west, and is probably the leader in America. Over 50 school playgrounds are fenced, equipped and supervised for play after school hours, and maintained every day.

"The work of the Institute will include the study of enclosing and screening playgrounds and other improvement in ways likely to render them desirable instead of detrimental to their several neighborhoods."

A CLEMCO DESK



A "CLEMCO" Da Vinci Suite in the private office of Mr. Bulova, President, Bulova Watch Company, Empire Trust Building, New York. Installation made by Flint & Horner Company, Inc., New York.

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THE
ARCHITECTURAL FORUM

VOLUME LI — OCTOBER 1929

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FLOOD IN BANK

....rips linoleum from floor tears veneer from table....

TELESCO PARTITION PRACTICALLY UNSCATHED

A FEW weeks ago, on a Sunday, a bursting water main precipitated tons of water into the Director's Room in the Bank of Yorktown, New York City. For practically an entire day the room stood in 2 feet of water. After the water was pumped out, here is what they found:

1. *The linoleum had been ripped clear off the floor and had been floating in the room.*

2. *On the expensive Director's Table in the center of the room, the veneer had been torn away.*

3. *On a coupon booth just outside the room, the finish of the wood was utterly ruined.*

With such havoc around it, you would expect the partition to be a total loss. You might expect it to collapse from the water pressure. Certainly its finish must be destroyed. But as a matter of fact the partition was practically unscathed. For it was Telesco Partition. Its beautiful walnut finish was unharmed, thanks to the exclusive lacquer used. The partition was as rigid as ever except at one point where shelves of stationery stored behind it came tumbling down against it! "We were amazed," writes Mr. J. O'Brien, vice-president of the bank, "at the remarkably fine appearance of the Telesco Partition in contrast to the other equipment in the room!"

Put Telesco under any test... for durability of finish, for ease of erection, for movability, for *real* economy... and its practicability will amaze you; just as its beauty, in luxurious American Walnut or African Mahogany, will impress the most exacting tenants.

HENRY KLEIN & CO., INC.

with which are consolidated Improved Office Partition Co. and Driwood Corp. (Est. 1909)

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Branch Offices in
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Factory: Elmhurst, N. Y.

Telesco Partition
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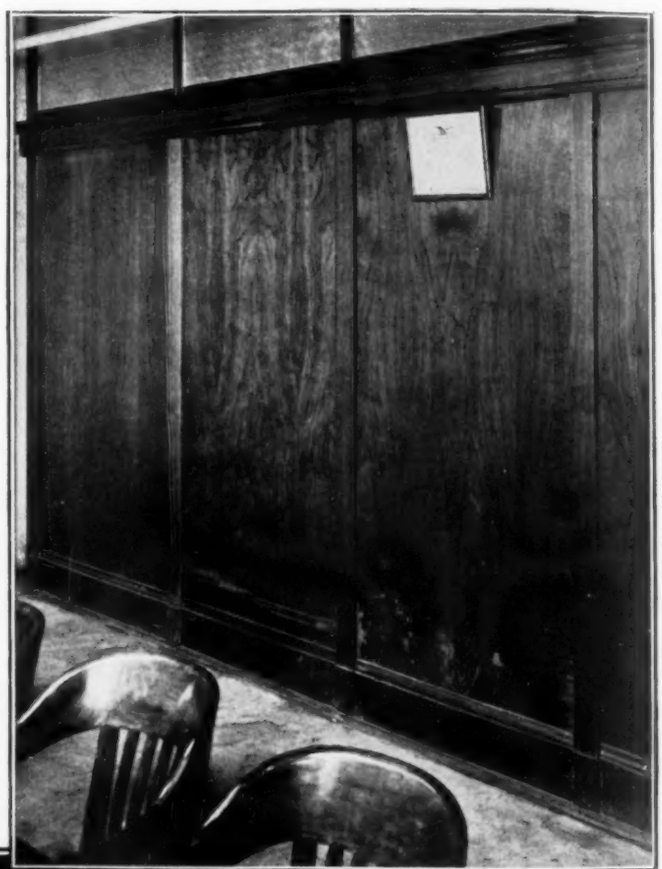


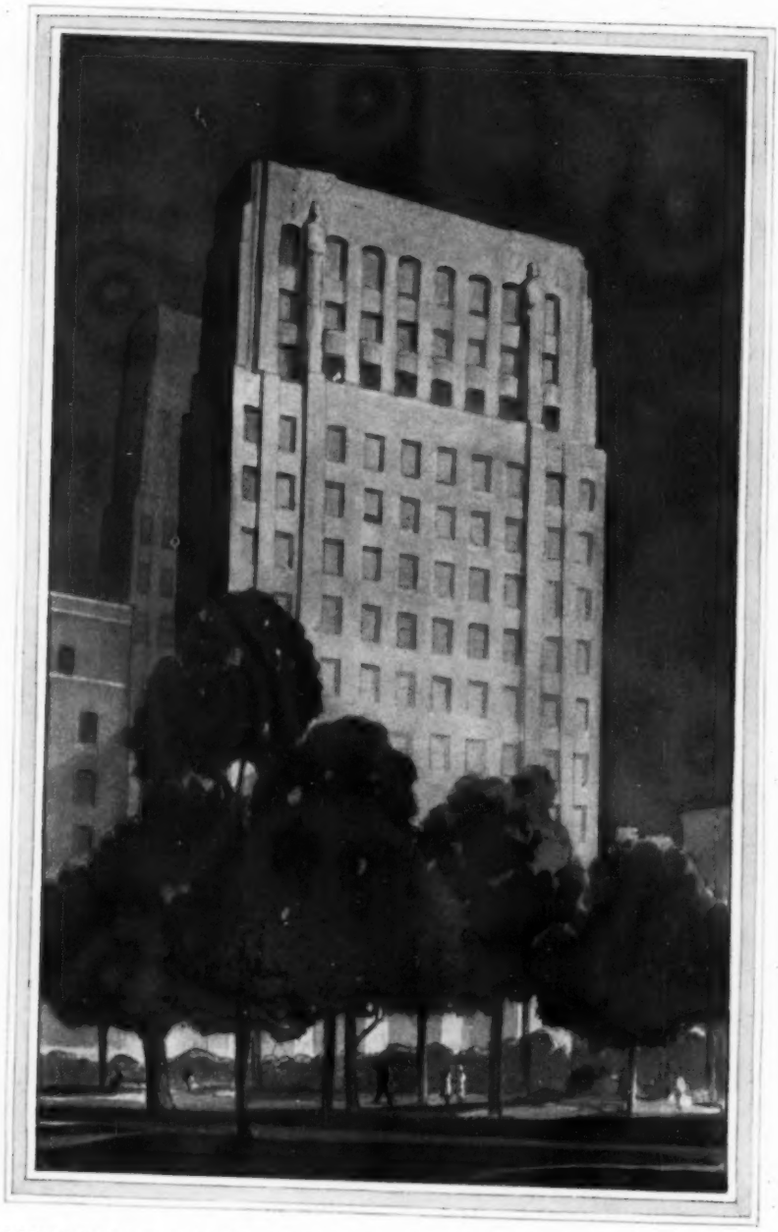
AFTER THE FLOOD

(Photos shown were not retouched)

Above: Telesco Partition, unharmed. At left: Leg of Director's Table, showing how veneer had been ripped away.

An Invitation

Just off Fifth Avenue, at 40-46 West 23rd St., Henry Klein & Co., Inc. has opened a huge store. Here you will find beautiful examples of paneled rooms for office and home... as well as model offices displaying the use of various types of Telesco Partition. We invite you to come in ... for it is a veritable architectural exposition of craftsmanship in wood.



BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA

RALPH B. BENCKER, ARCHITECT

From a Water Color Drawing by Norman C. Reeves

THE
ARCHITECTURAL
FORUM

VOLUME LI NUMBER FOUR

OCTOBER 1929

THE AYER BUILDING, PHILADELPHIA

BY

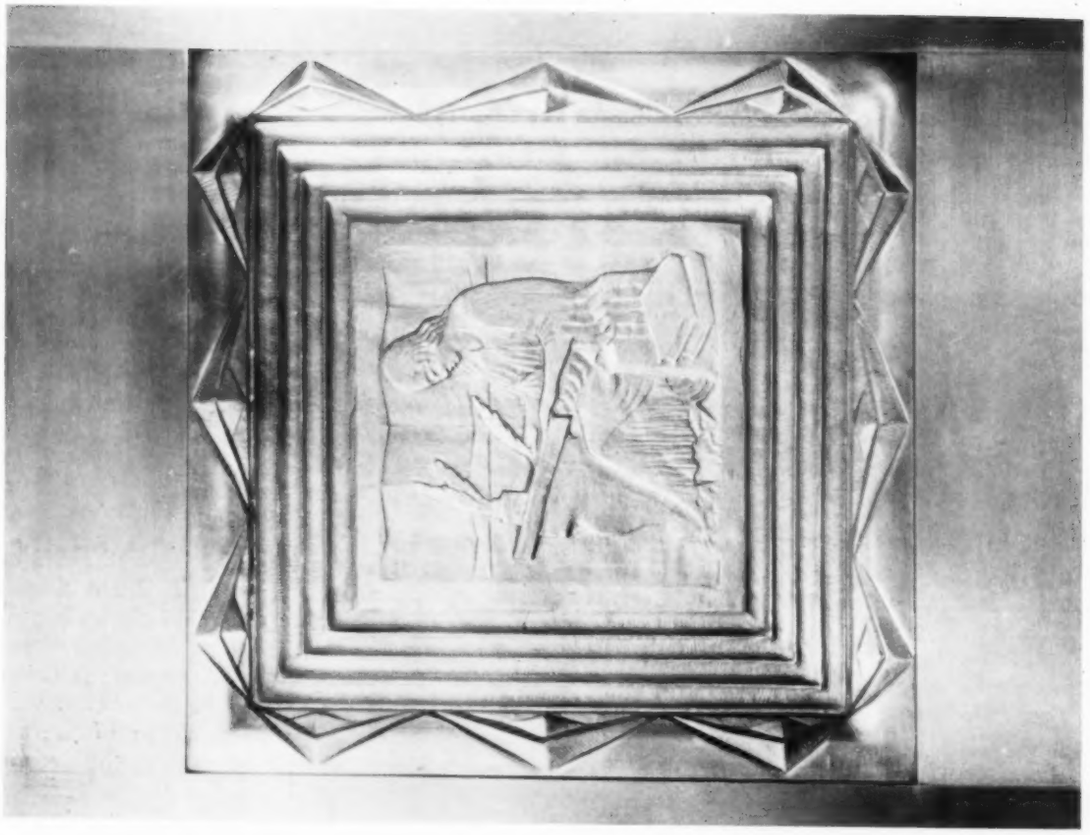
RALPH B. BENCKER, ARCHITECT

N. W. AYER & SON, INC., had looked forward for several years to the time when they would erect a building to properly house their large advertising organization. They had decided, before they engaged their architect, that the design of this structure should not follow any of the established styles of architecture. In an early discussion with me they expressed a desire for a building with all the beauty and dignity of the Lincoln Memorial, but of a design forward-looking, and of the present day. The problem, then, was not to build a monument, but to create an efficient and appropriate structure of simplicity and beauty as a home for the creation of advertising. Together we undertook this work, realizing fully the great opportunity that the problem offered, and realizing also the great responsibility that was placed upon us.

The building of N. W. Ayer & Son, Inc., faces east and overlooks historic Washington Square which was laid out as a park by William Penn. Diagonally across the way is Independence Square, with the old Pennsylvania State House, home of the Liberty Bell, and directly to the rear is the Morris house, dating from the early days of the country. We endeavored to create a design which, while new, would bring no jarring note to this old section of Philadelphia. The exterior of the building is a simple shaft, 13 stories high, of "shot sawed" buff and variegated Indiana limestone, with the three upper stories set back to give a receding, graceful silhouette. The first ten stories measure on the outer walls 103 by 115 feet, with a floor area each of approximately 9,000 square feet after space is deducted for light wells, elevators and stairways. Starting at the line of the setback, flanking each elevation, are two pylons growing out of the strength of the lower masonry, terminating in figures of "Truth," representing the advertising business distributing information to the four winds. These figures were studied to play by form and light and shade interestingly with the silhouette of the building formed by the corner piers. The spandrels below the uppermost arched windows are carved with figures symbolizing the organization of the advertising agency. The motifs used in the decoration of the interior and exterior of the structure were taken from fundamentals of the advertising business; they are the human figure, symbolizing the creative mind, and the figure of Truth; the open book as the vehicle of advertising; and the winged bird as the messenger, symbolizing the widespread power of advertising.

The main entrance to the building fronts the Square, and is in the center of the facade through a bronze and marble vestibule. In the frieze over the doors are two open books with figures representing Truth. In the center is the Sun, the source of inspiration, illuminating two seated figures representing the Executives, supporting one side of the books; on the other side are figures representing "Art" and "Writing." At each end are two figures representing "Youth." The doors are formed with panels modeled in low relief, symbolizing the activities of the various departments of the business of the agency. Directly above the entrance, and centering on the large windows facing the east side of the building, are three panels carved to represent interesting features having to do with the history of the N. W. Ayer & Son organization: the first, the plow; the middle panel, the lamp; and the north panel, the future.

The lobby, with its towering height extending through two stories, has its long axis north and south, with walls of unsually interesting rusticated limestone. To the south of the lobby are three galleries for exhibitions of art and other forms



CARVING IN LOBBY

PANEL ON ELEVATOR DOOR

BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA.
RALPH B. BENCKER, ARCHITECT

Photos, Charles Ogle

Photo. W. H. Hoodt

MAIN FACADE

BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA

RALPH B. BENCKER, ARCHITECT

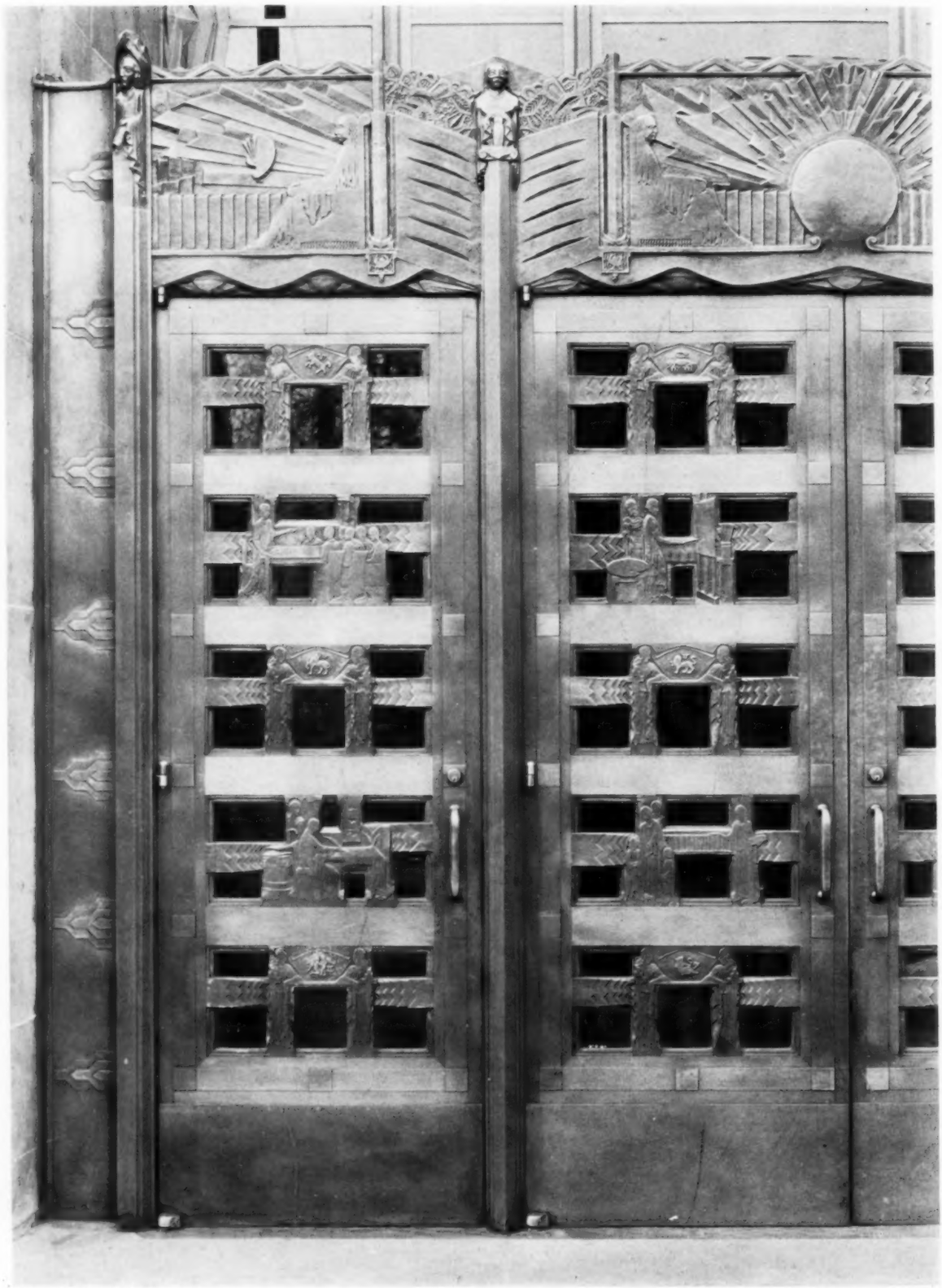


Photo. Charles Ogle

MAIN ENTRANCE DOOR
BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA
RALPH B. BENCKER, ARCHITECT

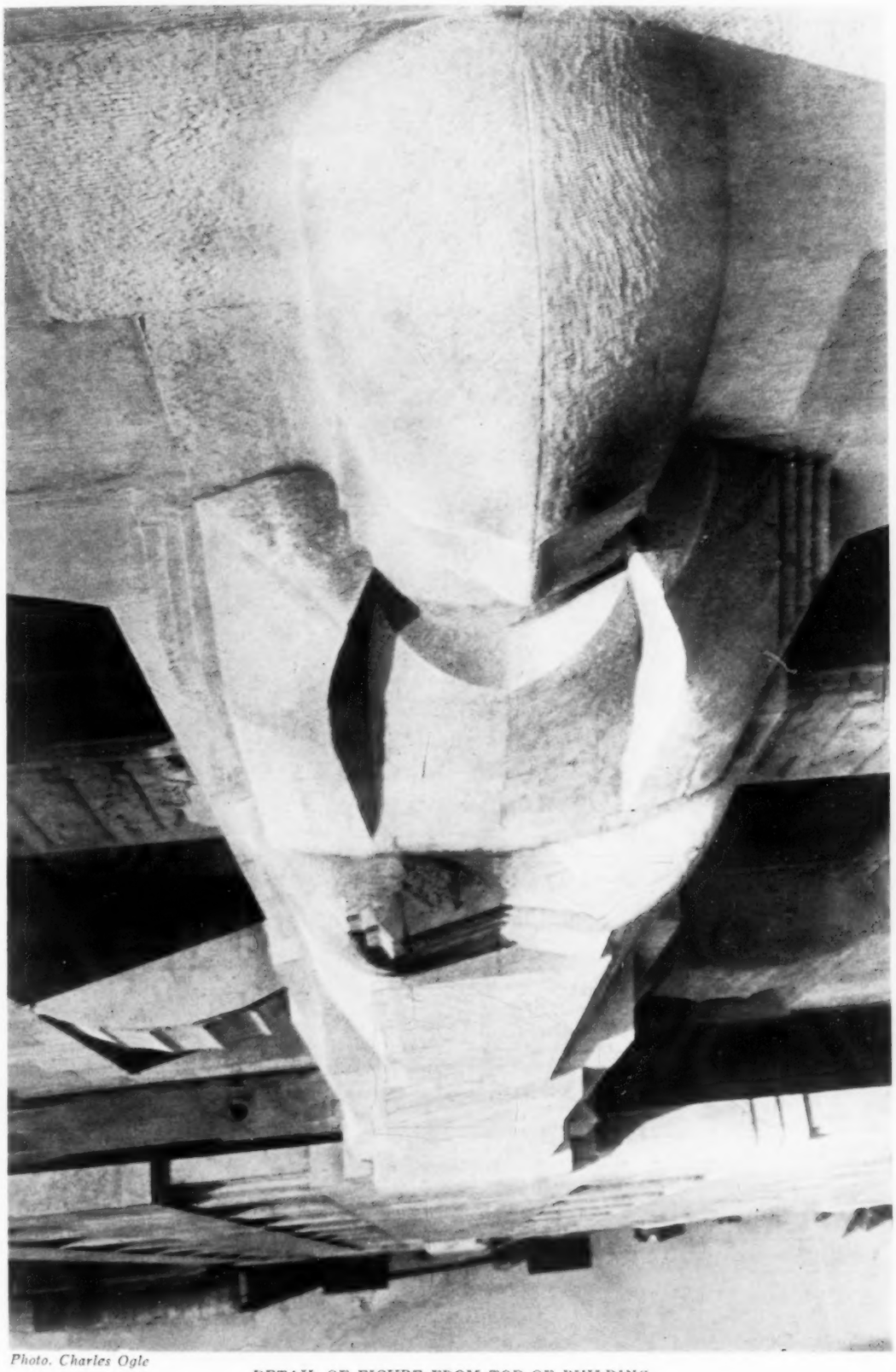


Photo. Charles Ogle

DETAIL OF FIGURE FROM TOP OF BUILDING
BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA
RALPH B. BENCKER, ARCHITECT

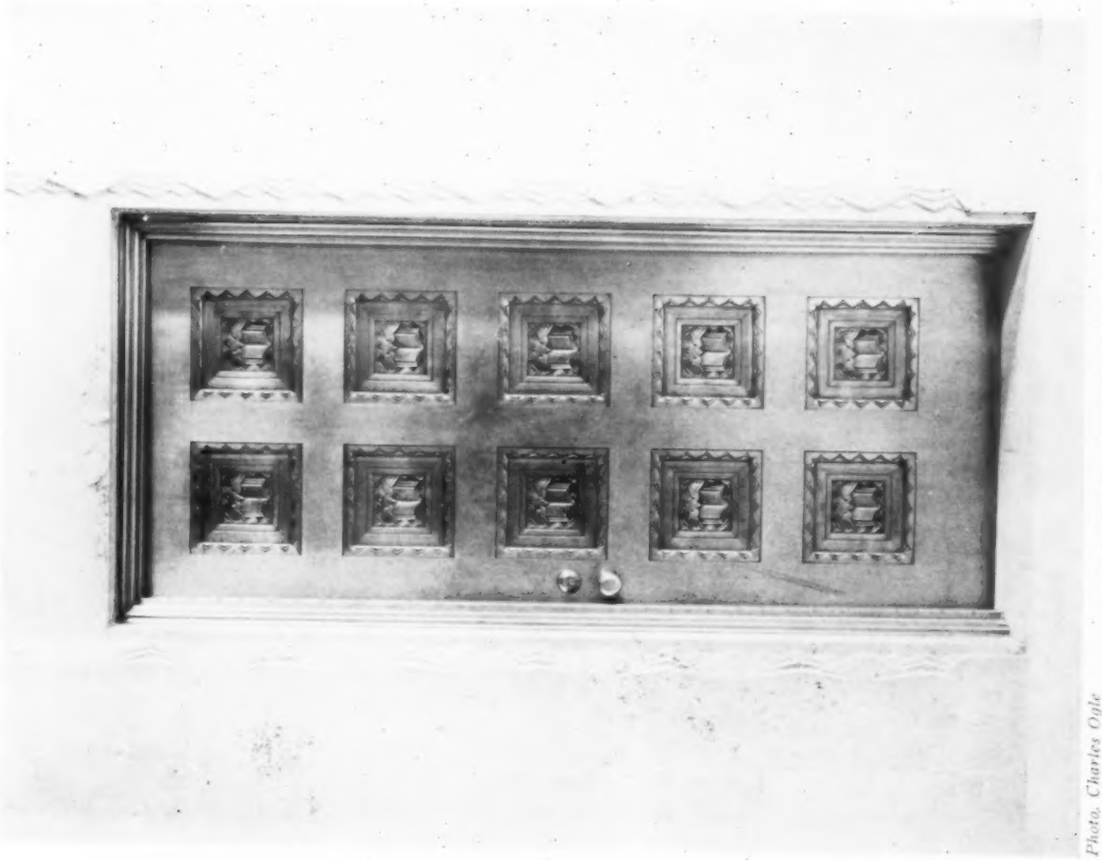


Photo. Charles Ogle

DOOR FROM ELEVATOR LOBBY
BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA
RALPH B. BENCKER, ARCHITECT

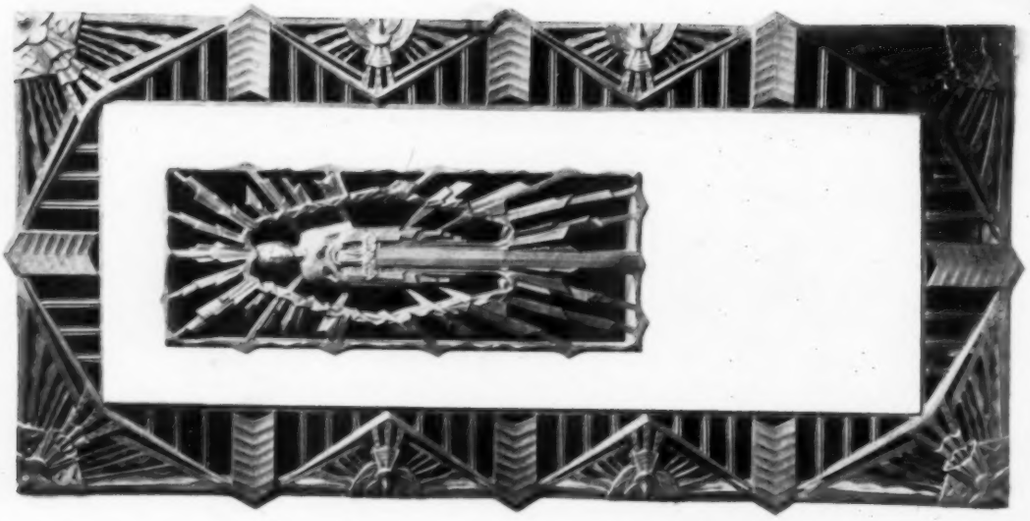


Photo. Sigurd Fischer

RADIATOR ENCLOSURE, MAIN LOBBY
BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA
RALPH B. BENCKER, ARCHITECT

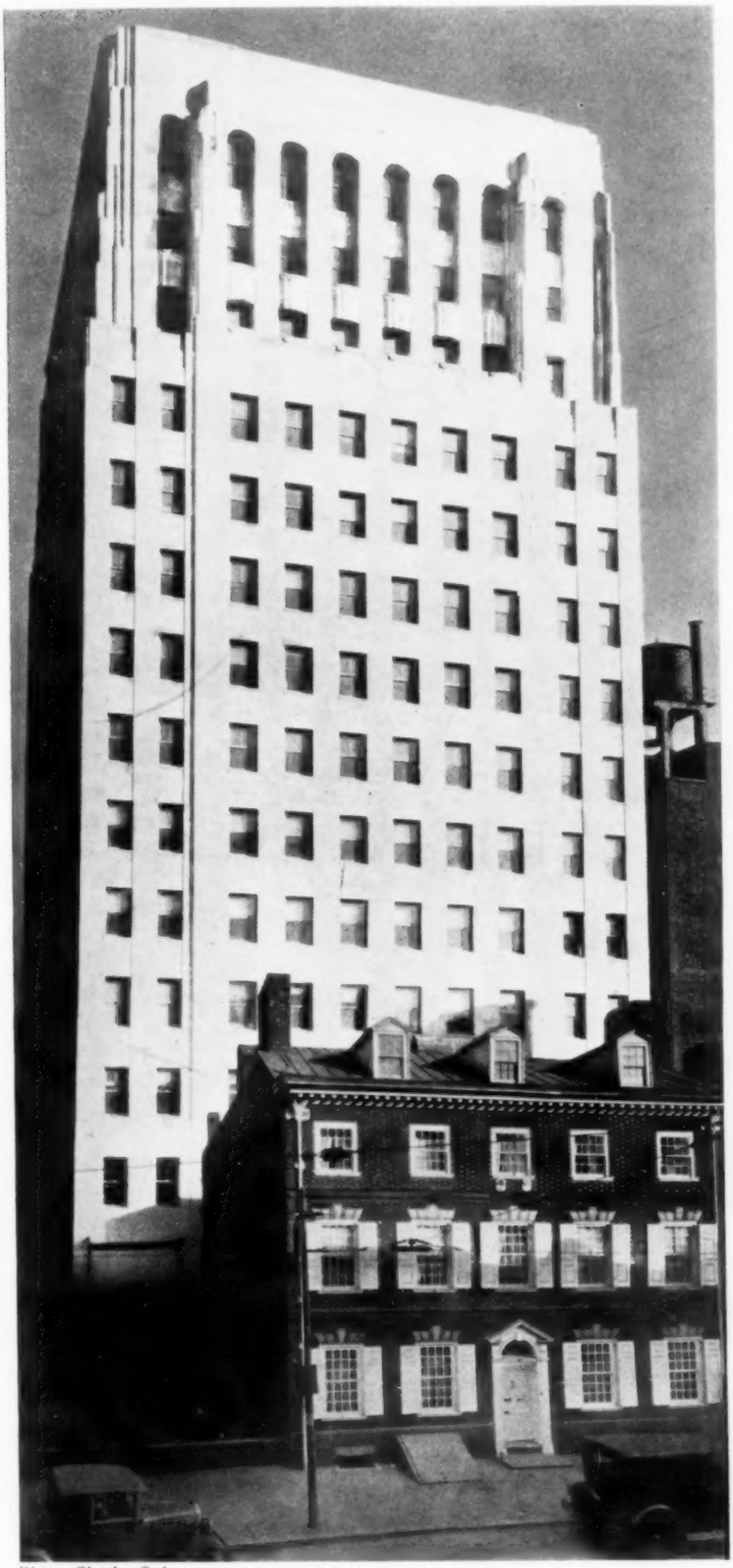


Photo. Charles Ogle

BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA
RALPH B. BENCKER, ARCHITECT

of the work which has to do with advertising. The walls are of texture fabric with paneling in walnut. The main gallery has walls of a soft gray-green fabric with three painted horizontal bands of receding black, extending into the dull blue of the curved ceiling lines above. When seen through the stone opening from the lobby, this gallery adds a charming color note to the lobby setting.

On the west side of the main lobby, directly opposite the entrance, is the elevator lobby with its walls of soft colored limestone, topped off with an indirect light cove, in which are used cast glass inserts which produce an interesting effect in that they eliminate the hard, dark line which is usual in indirect lighting coves. The cast glass is below the top line of the cove member, and by its faceted sides it diffuses the light rays directly below and above, and softly blends the light above the cove with the walls below. Between the main entrance hall and elevator lobby there is a pierced limestone grille carved in design which shows rays, as of light, radiating from the emblem of N. W. Ayer & Son to various races of the globe. This grille, when seen from the entrance hall or from the elevator lobby presents an interesting decoration because of the play of light, since one side has indirect light, the other direct light.

The space on the first and second floors not occupied by the entrance and gallery is used for the printing department. This space has been soundproofed, and the presses have been mounted on platforms of cork so that in the lobby or in any other part of the structure there is no indication that huge, pulsating, vibrating machines are operating just on the other side of the lobby walls. The various other departments occupy the typical floors up through the building to the 13th. These floors are all planned with a maximum of light, with flat ceiling underfloor duct system, and a system of artificial light distribution to allow for the greatest possible flexibility in department arrangement and future growth. Throughout the building it has been the aim to provide the most favorable of working conditions, not only in the matter of light, air and elbow room, but also in an arrangement of departments which permits of the close coöperation necessary in a well knit and cohesive organization. Throughout the structure, temperature regulation was installed, controlling the radiators which are all concealed within the walls under the windows, covered with metal plates and painted in colors to match the walls, giving to the various floors an unusually fine appearance and a clear floor span.

On the 12th floor are the executive offices and main conference rooms. The entire 13th floor is used for an assembly hall and cafeteria, in which the organization can be brought together on both business and social occasions. The roof is used for recreation, being paved with tile, and from it there is obtained a wonderful view over the city and the Delaware River with its shipping.

On the occasion of the laying of the corner stone of the new building, February 4, 1928, the 80th anniversary of the birth of the founder of the firm, F. Wayland Ayer, the president of the corporation, Wilfred W. Fry, outlined in brief fashion, the general scheme on which the structure was erected. "In preparing for this new building," he said, "we took ample time for planning, we have sought to let purpose and material control design, to mould form to decoration rather than decoration to form, and to approach architecture through logical, structural channels. We believe this new home will fulfill in completeness, efficiency, comfort and simple dignity all that we can hope for in this modern structure of steel and stone. It is safe to assume that with such a building, planned, arranged and equipped to meet our particular needs, with facilities coördinated by many years of experience, in the light of modern practice and with the help of modern mechanical devices, our service to our clients should be measurably quickened and broadened."

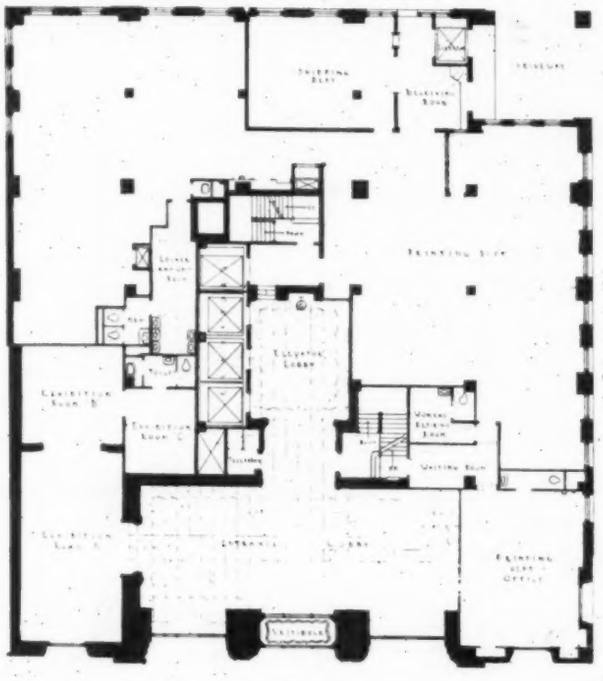
The pride which every individual in the Ayer organization feels in its new business home, is summarized in the words of one of them: "There are some in the advertising business, outside of our organization, who have seen in this new building a significance beyond its immediate importance to us. They have said, graciously, that it is a symbol of the stable state to which the advertising business has been brought, as an accepted force in modern industry and commerce. It is natural that we should like to feel that this is true, because ever since this business was founded by Mr. F. Wayland Ayer in 1869 it has been the earnest purpose of him and the organization to conduct an advertising business that would command the respect and confidence of the public."

Photos. Sigurd Fischer *Plans on Back*

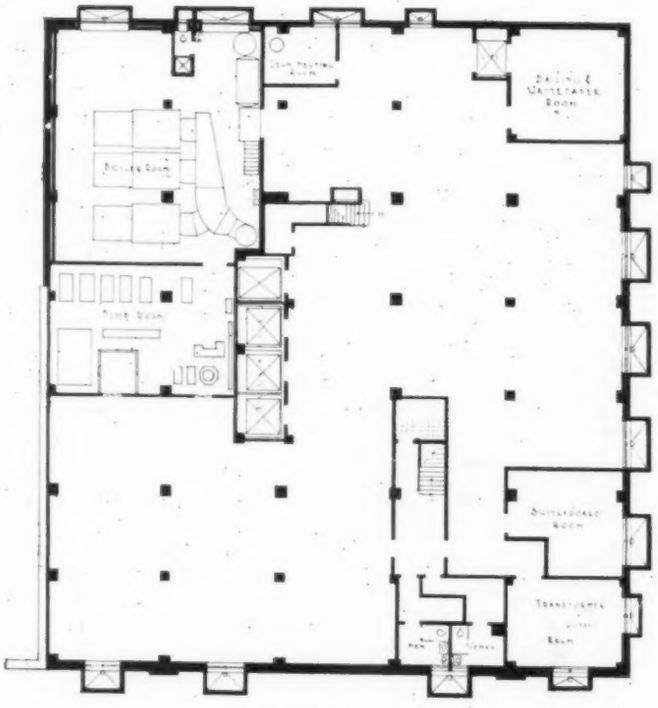
WASHINGTON SQUARE FACADE

BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA

RALPH B. BENCKER, ARCHITECT



FIRST FLOOR



BASEMENT FLOOR

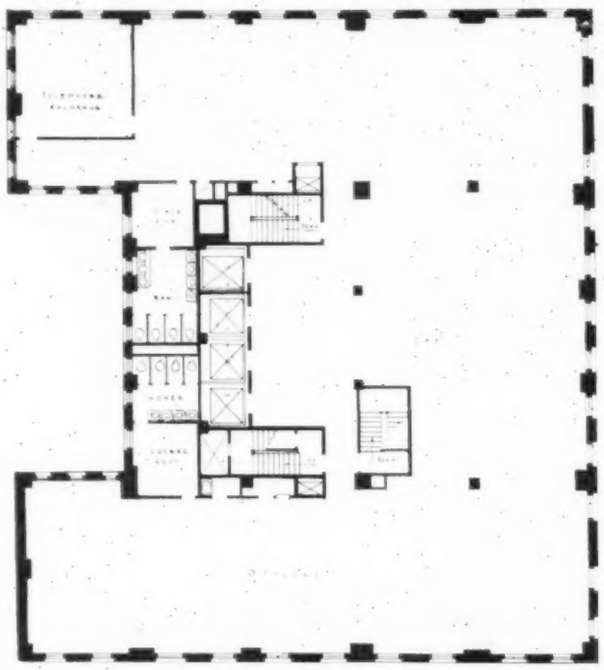
PLANS. BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA
RALPH B. BENCKER, ARCHITECT

Plans on Back

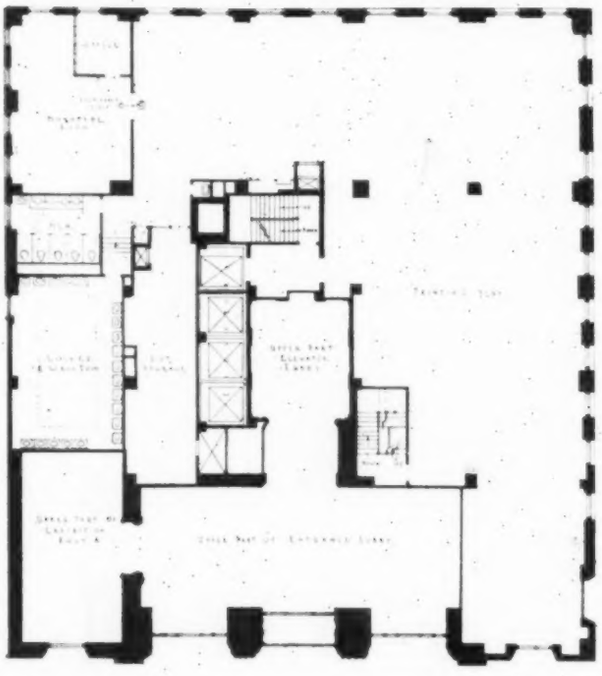
FRONT ELEVATION

BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA

RALPH B. BENCKER, ARCHITECT

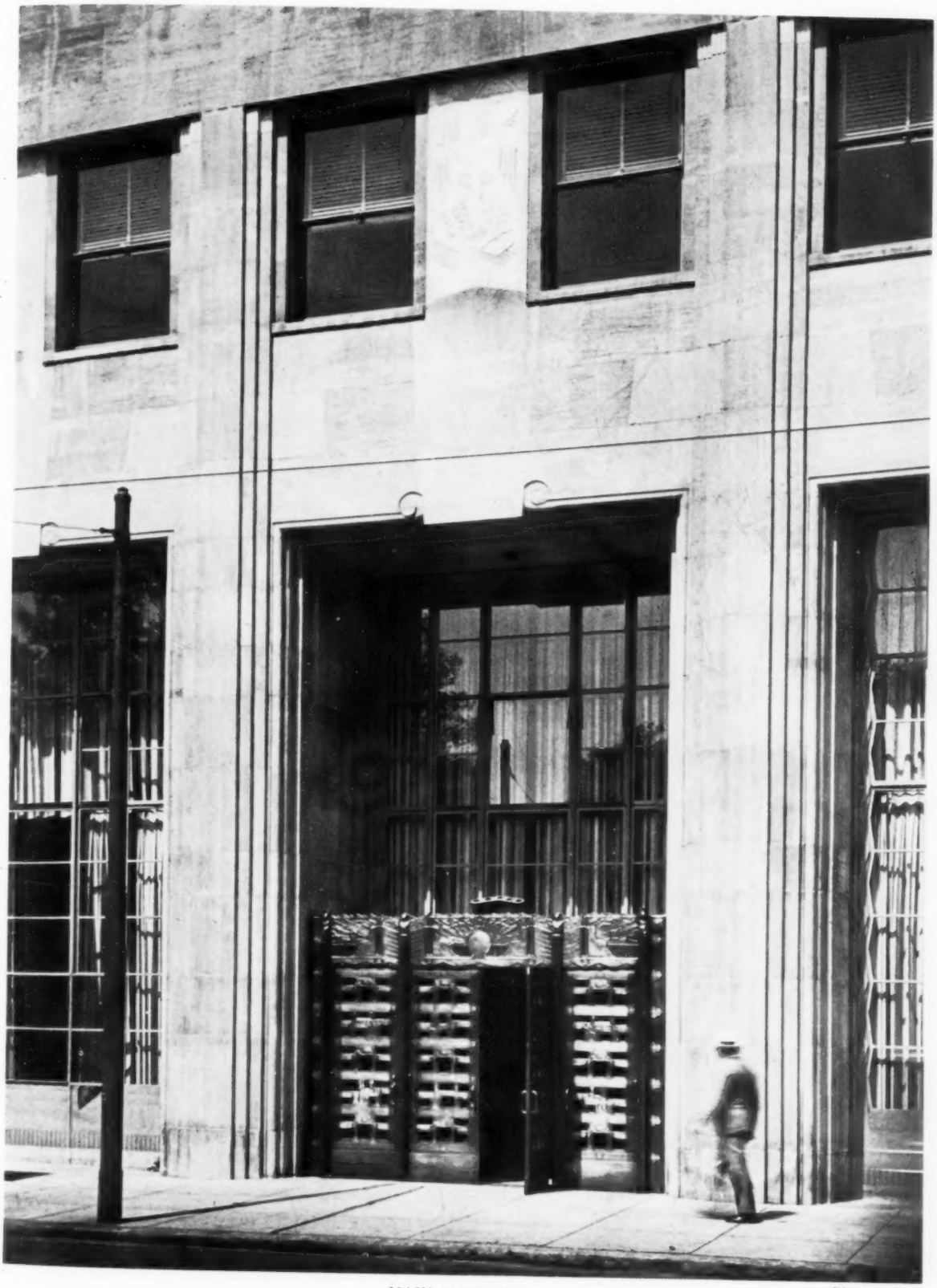


SECOND FLOOR



MEZZANINE FLOOR

PLANS, BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA
RALPH B. BENCKER, ARCHITECT

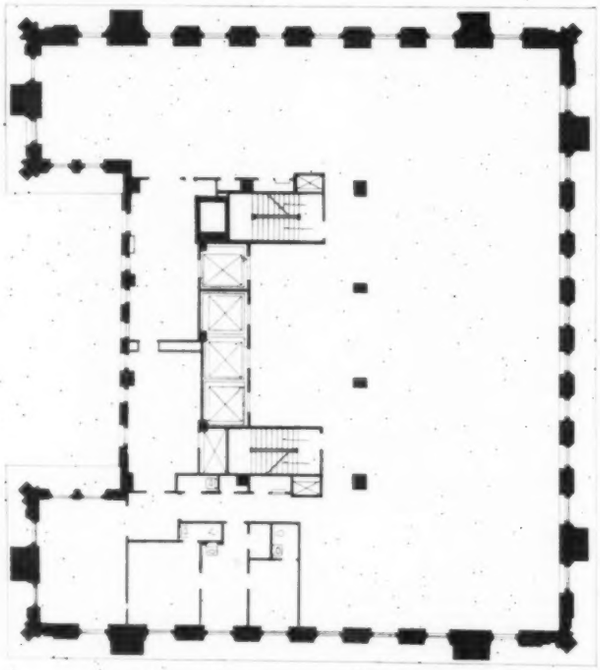


MAIN ENTRANCE

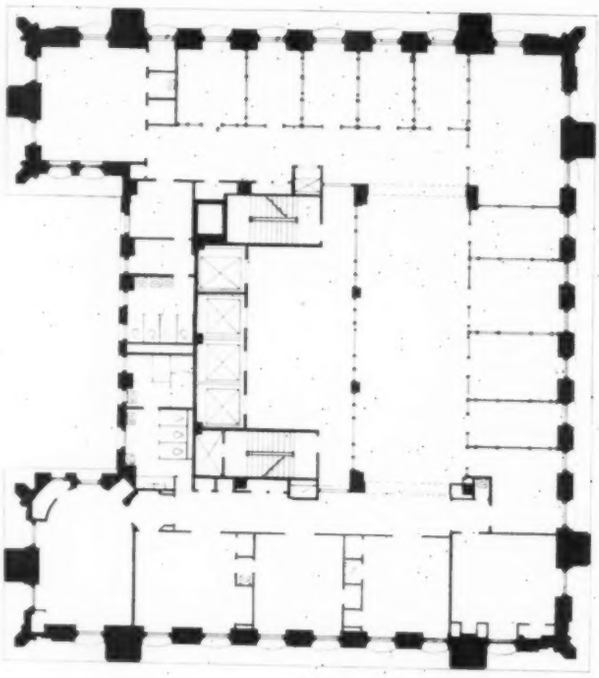
Plans on Back

BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA

RALPH B. BENCKER, ARCHITECT



THIRTEENTH FLOOR



TWELFTH FLOOR

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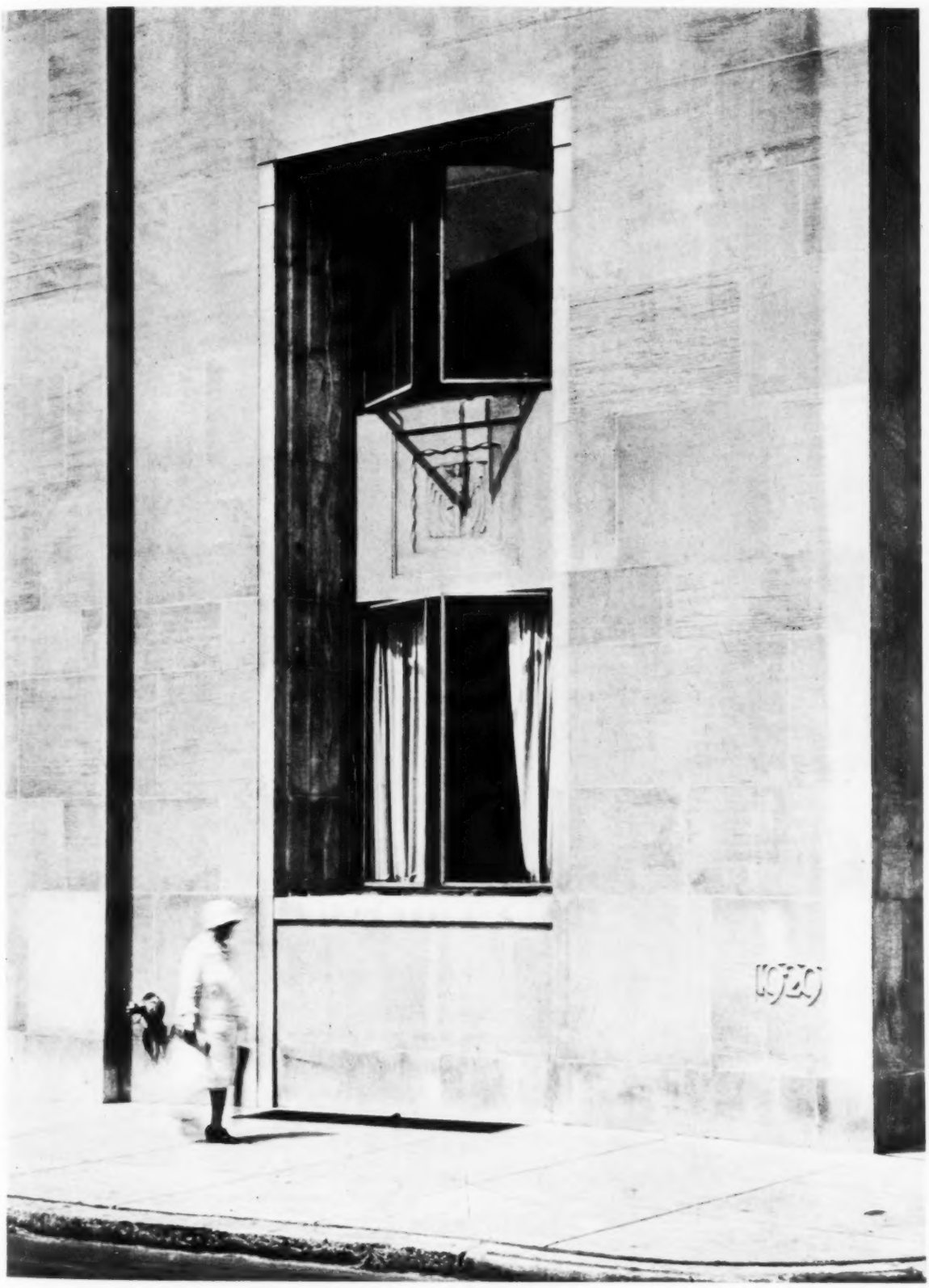
RALPH B. BENCKER, ARCHITECT



DETAIL, FRONT ELEVATION
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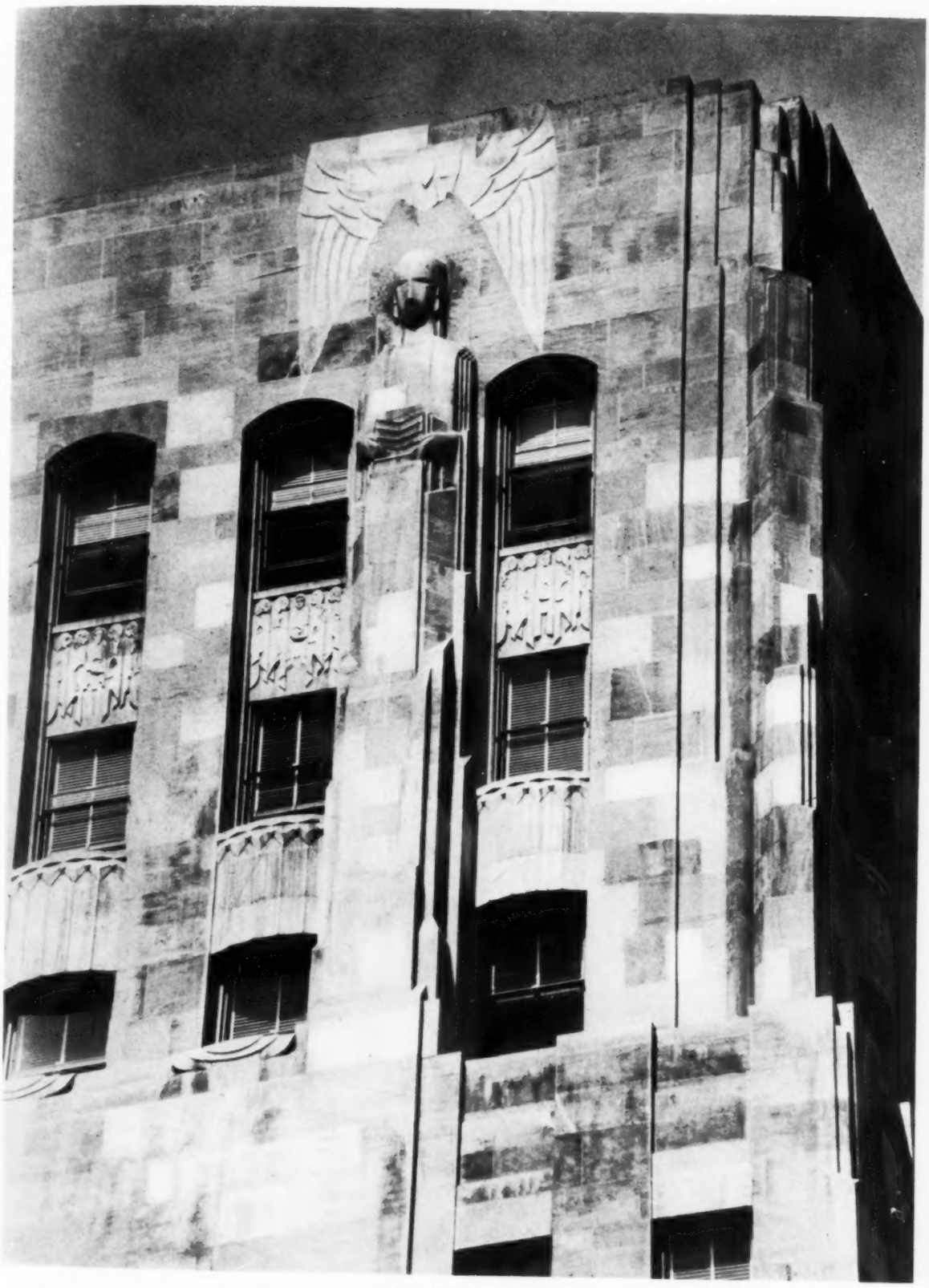
RALPH B. BENCKER, ARCHITECT



TOP OF BUILDING
BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA
RALPH B. BENCKER, ARCHITECT

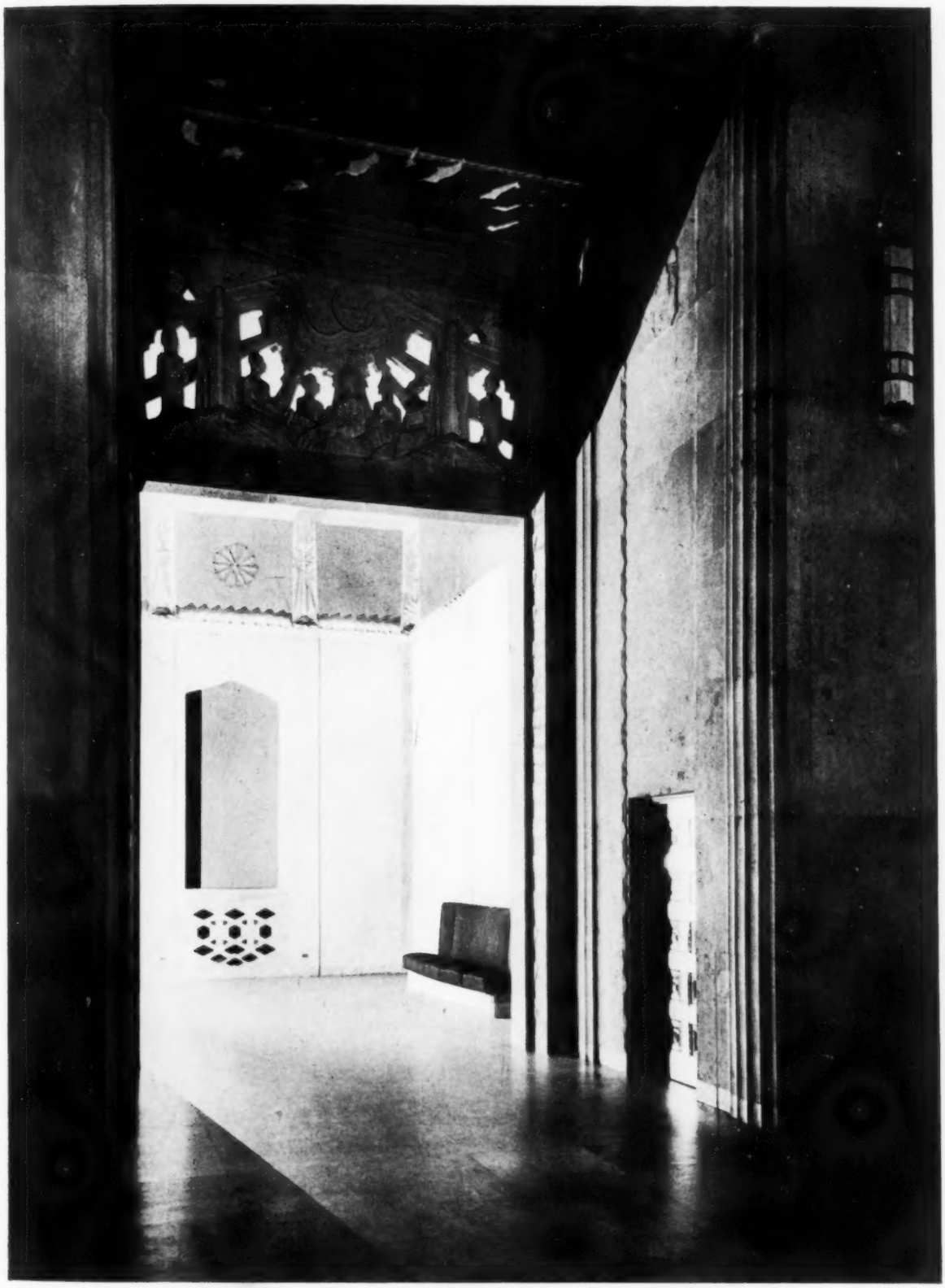
MAIN LOBBY
BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA
RALPH B. BENCKER, ARCHITECT

CEILING, MAIN LOBBY
BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA
RALPH B. BENCKER, ARCHITECT

DOORWAY IN LOBBY

BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA

RALPH B. BENCKER, ARCHITECT

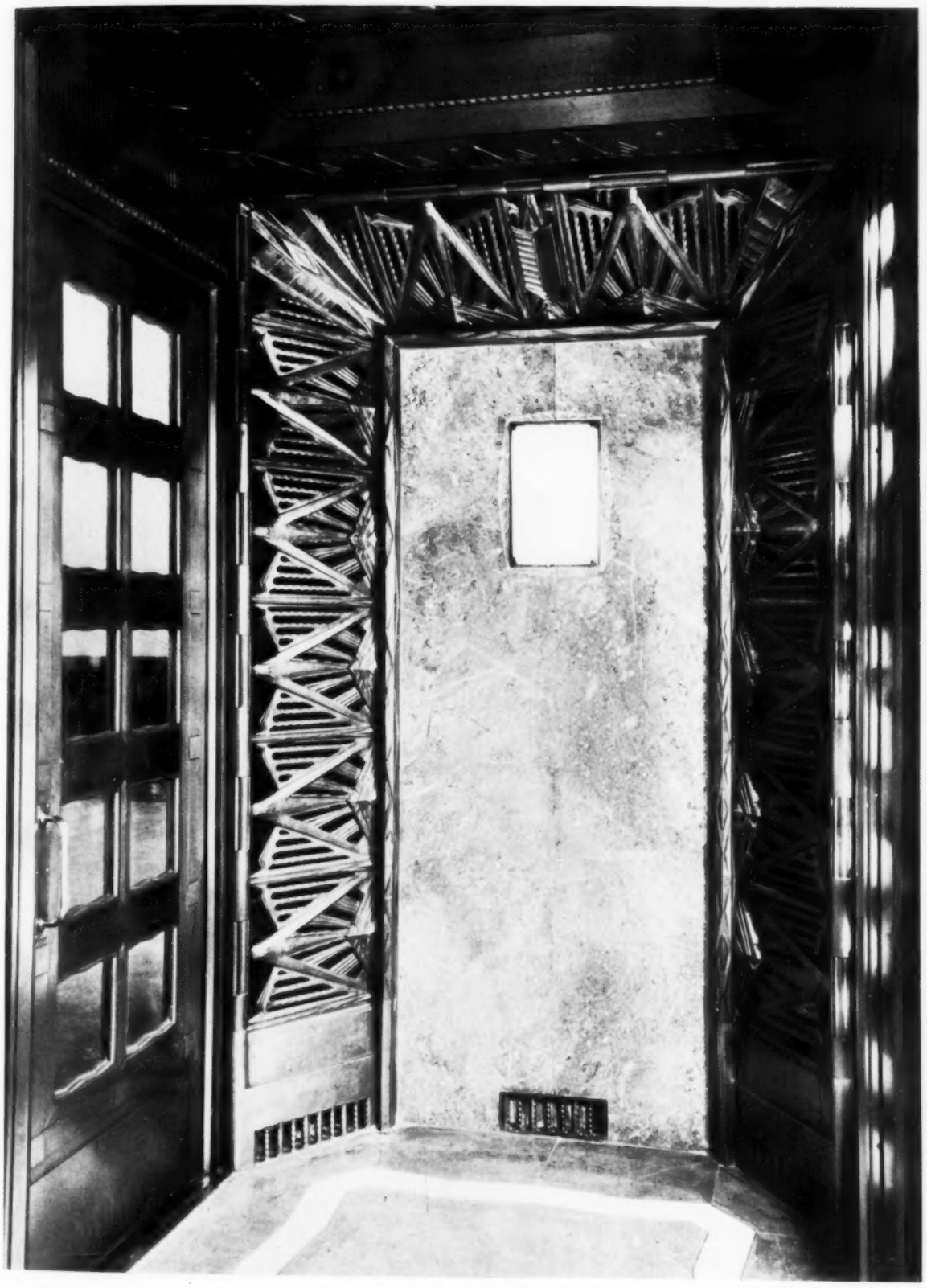


ENTRANCE TO ELEVATOR LOBBY
BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA
RALPH B. BENCKER, ARCHITECT

VESTIBULE, PRESIDENT'S OFFICE
BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA
RALPH B. BENCKER, ARCHITECT

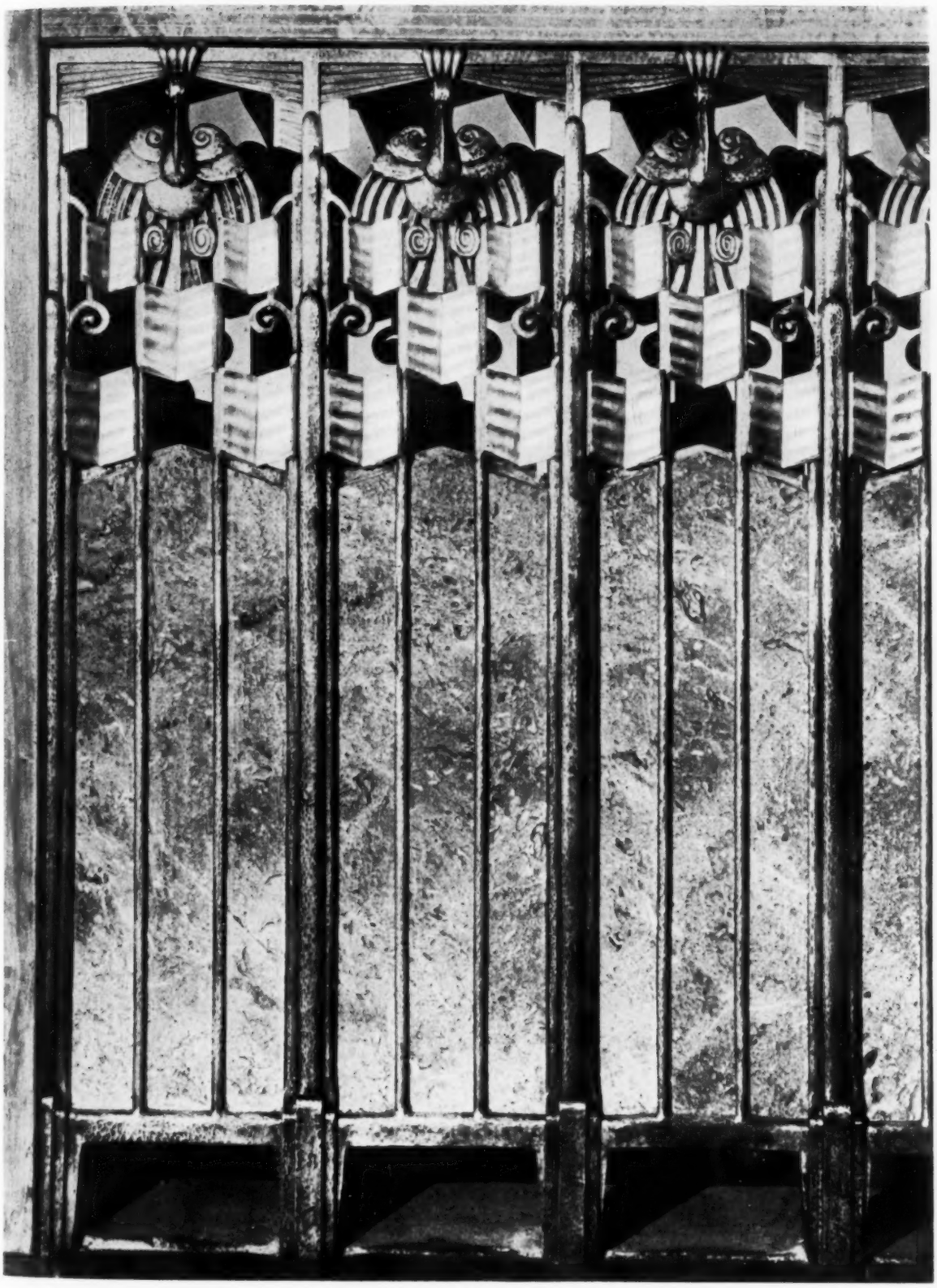
MIDDLE EXHIBITION ROOM, ART GALLERY
BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA
RALPH B. BENCKER, ARCHITECT

CEILING, MAIN EXHIBITION ROOM, ART GALLERY
BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA
RALPH B. BENCKER, ARCHITECT



OUTER VESTIBULE
BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA
RALPH B. BENCKER, ARCHITECT

ELEVATOR LOBBY, CAFETERIA FLOOR
BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA
RALPH B. BENCKER, ARCHITECT



RADIATOR ENCLOSURE, ART GALLERY
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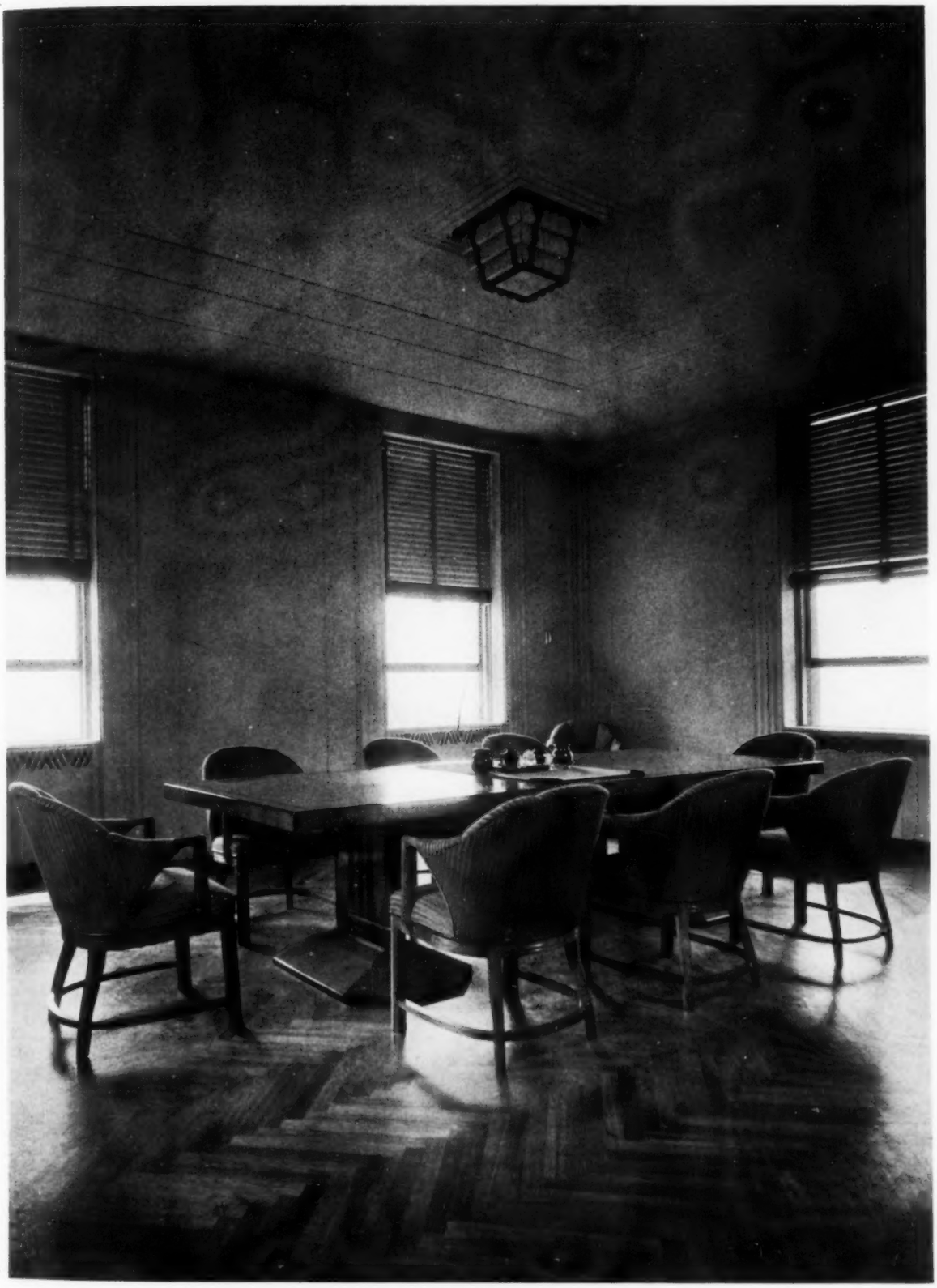
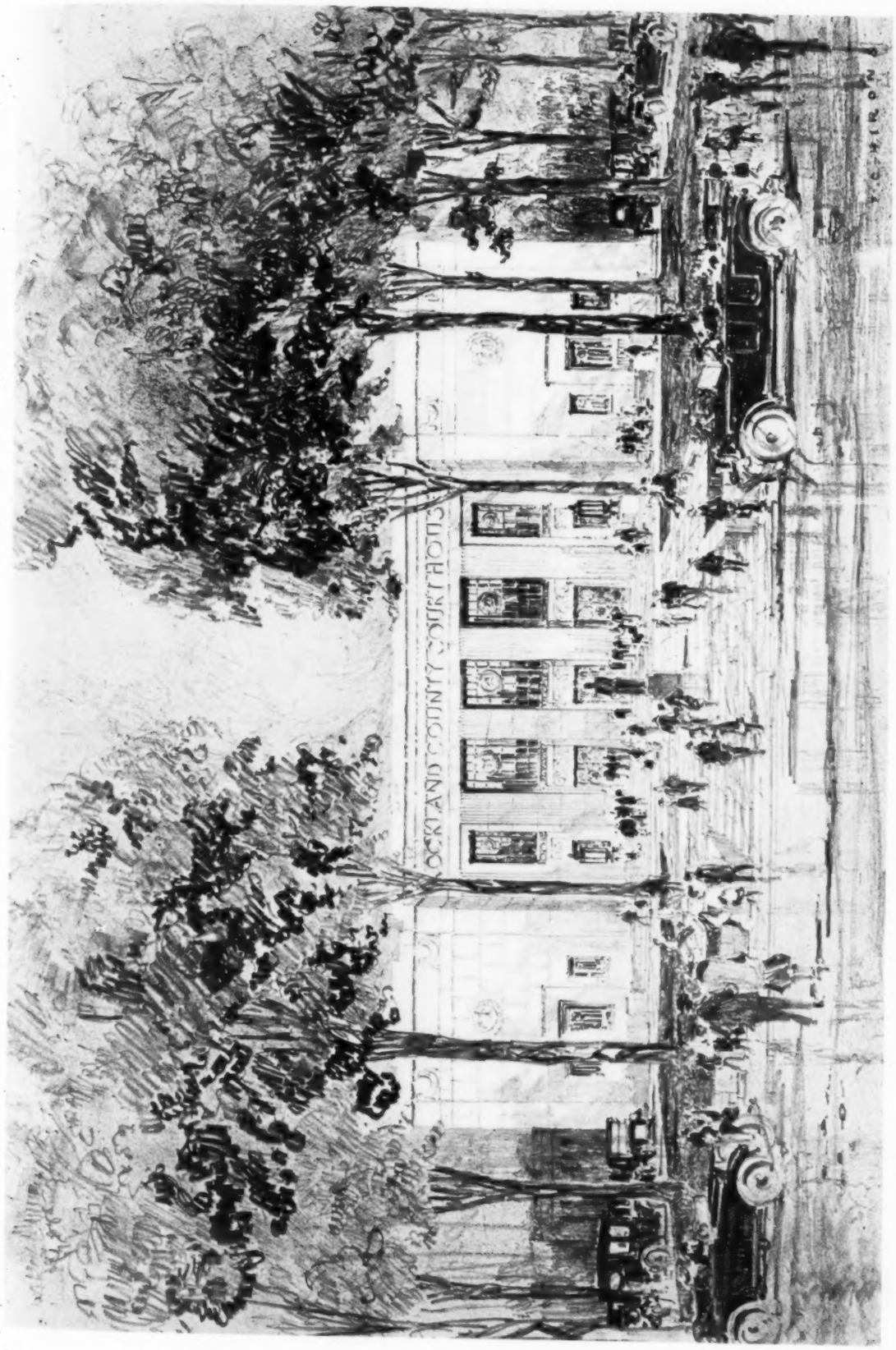
RALPH B. BENCKER, ARCHITECT

UNIV OF MICH

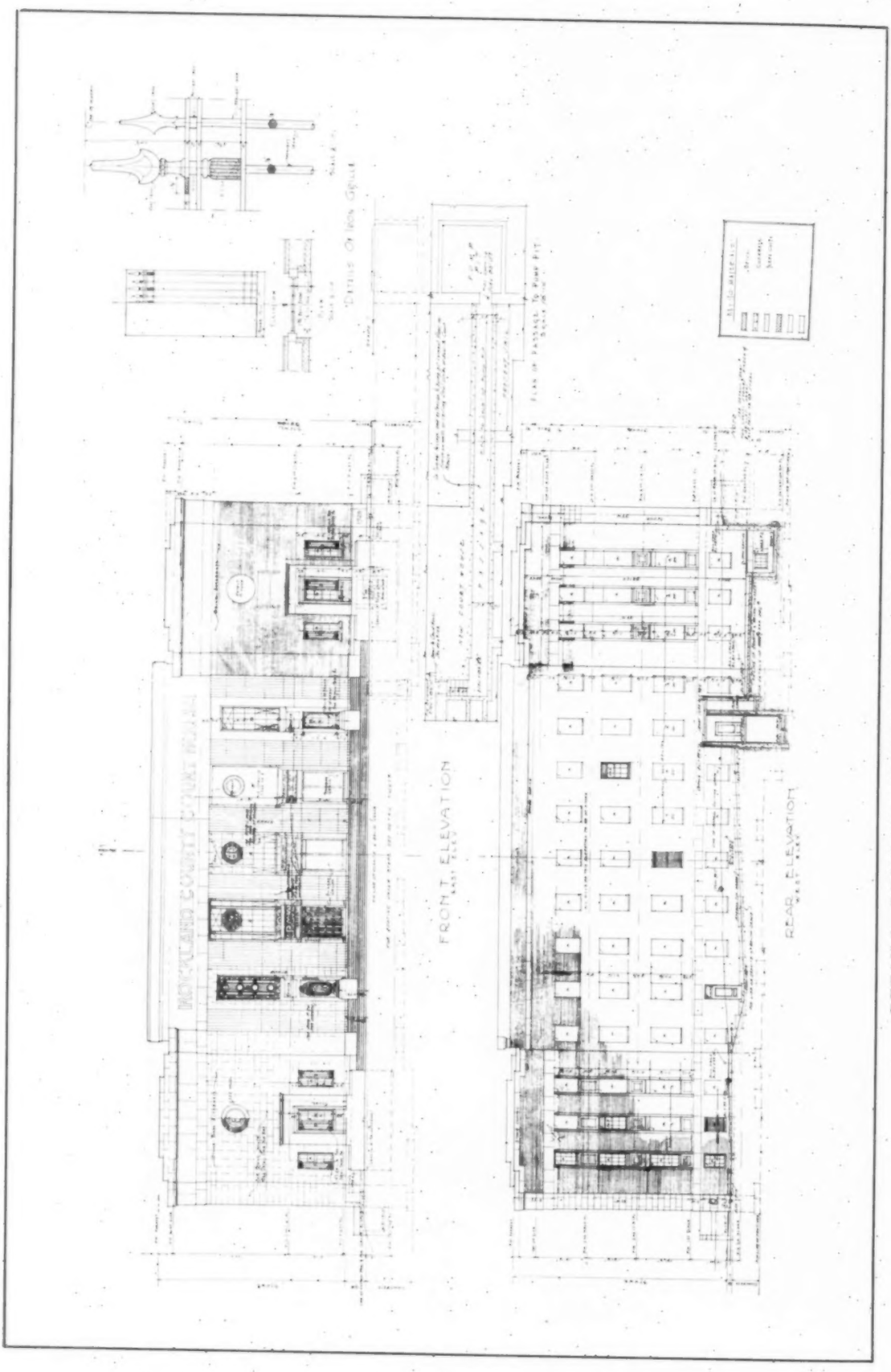


CONFERENCE ROOM
BUILDING FOR N. W. AYER & SON, INC., PHILADELPHIA
RALPH B. BENCKER, ARCHITECT

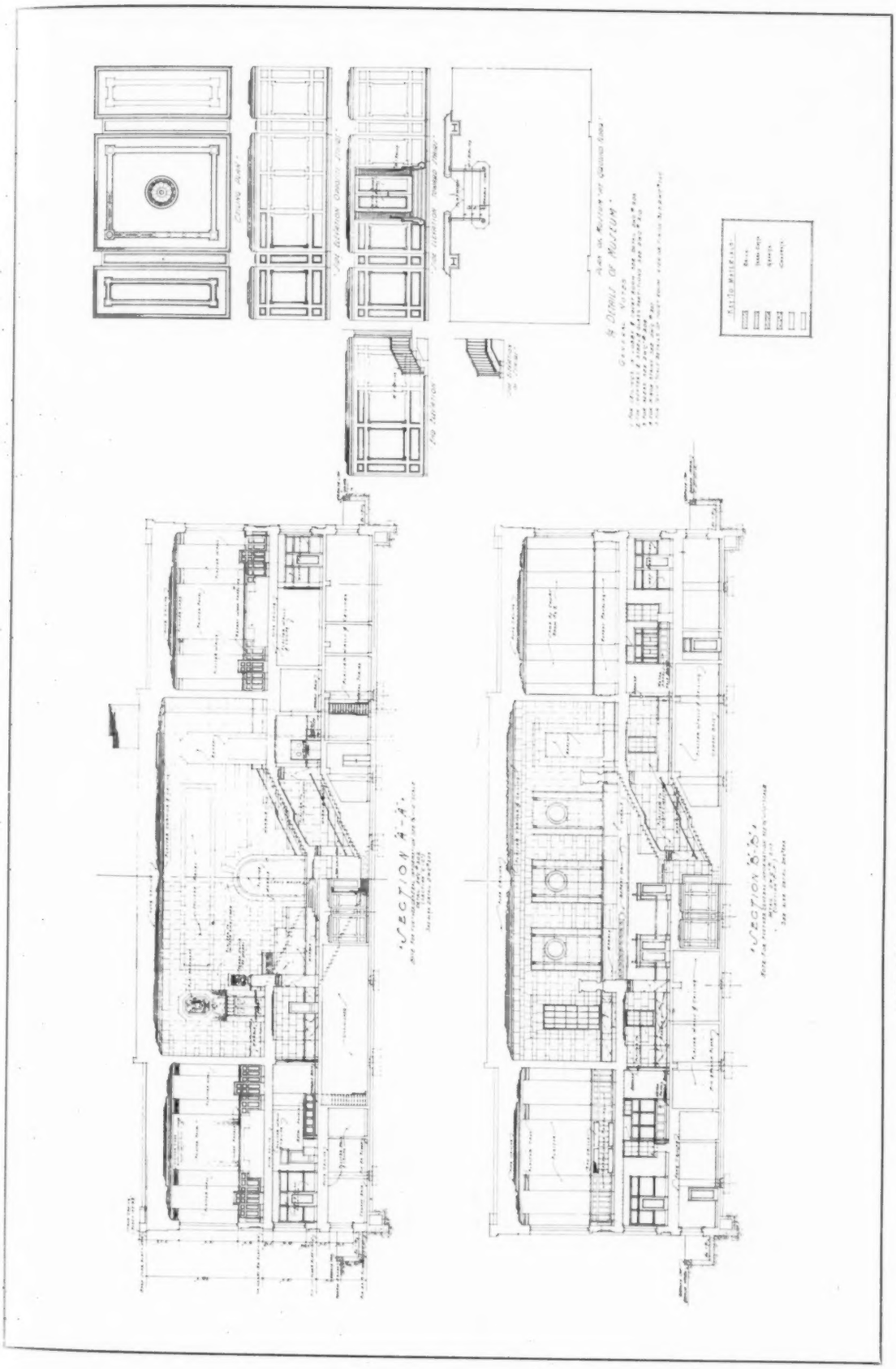
UNIV OF MICH



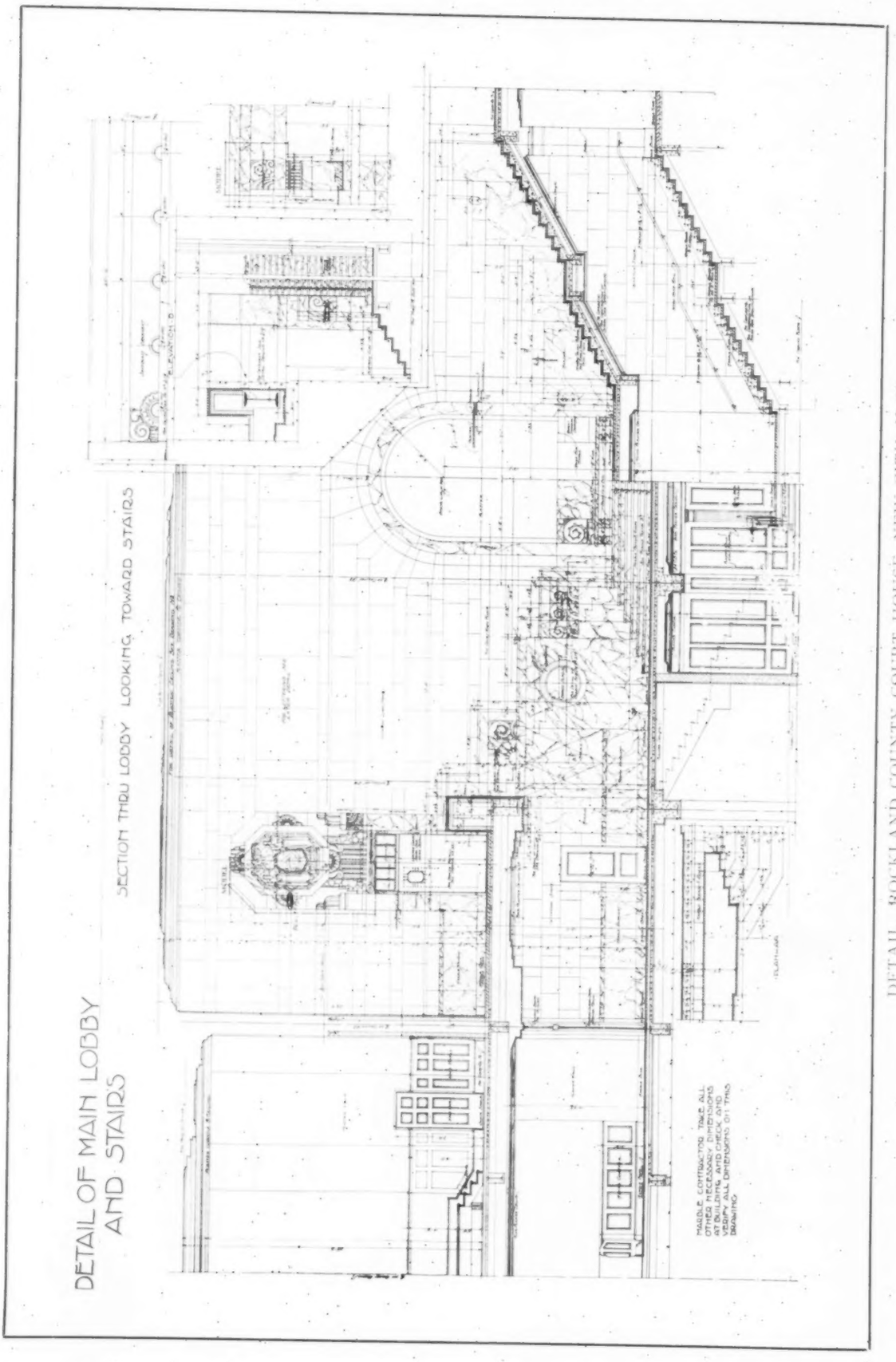
GENERAL VIEW
ROCKLAND COUNTY COURT HOUSE, NEW CITY, N. Y.
DENNISON & HIRONS, ARCHITECTS



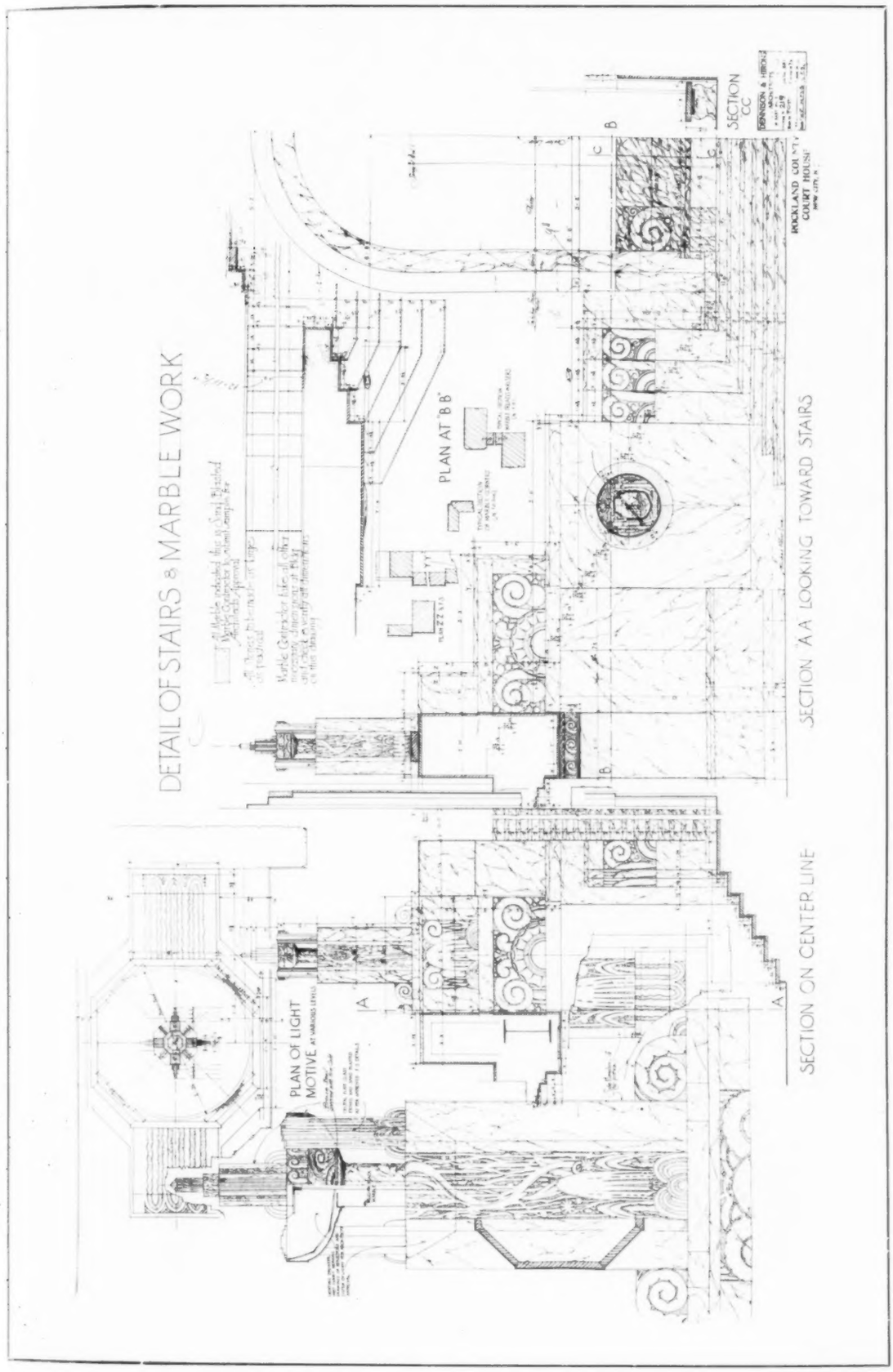
DETAILS. ROCKLAND COUNTY COURT HOUSE, NEW CITY, N. Y.
DENNISON & HIRONS, ARCHITECTS



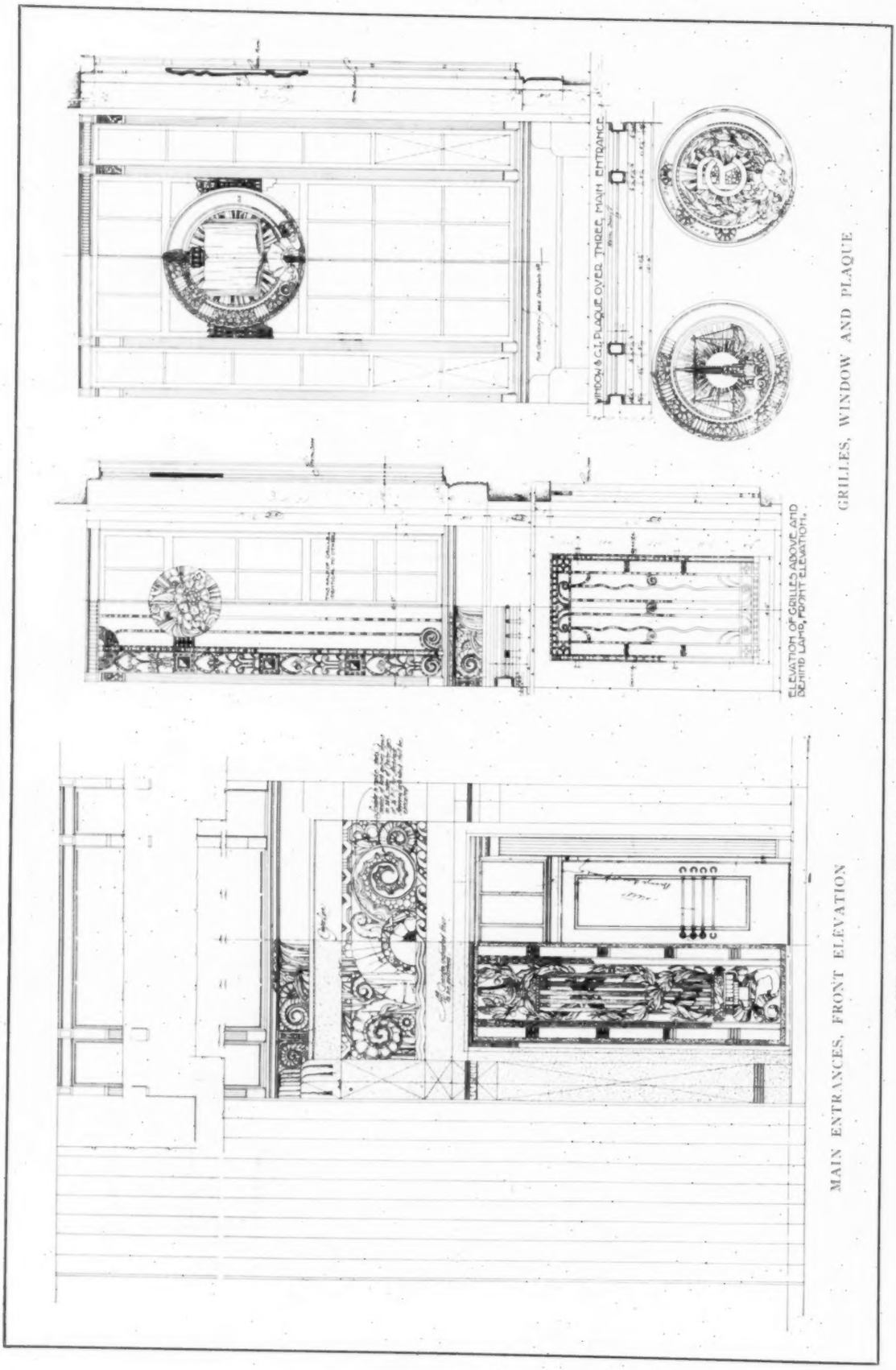
DETAILS. ROCKLAND COUNTY COURT HOUSE, NEW CITY, N. Y.
DENNISON & HIRONS, ARCHITECTS


DETAIL OF MAIN LOBBY AND STAIRS
SECTION THRU LOBBY LOOKING TOWARD STAIRS
MASON, CONTRACTOR TAKE ALL OTHER NECESSARY DIMENSIONS AT BUILDING AND CHECK AND VERIFY ALL DIMENSIONS ON THIS DRAWING

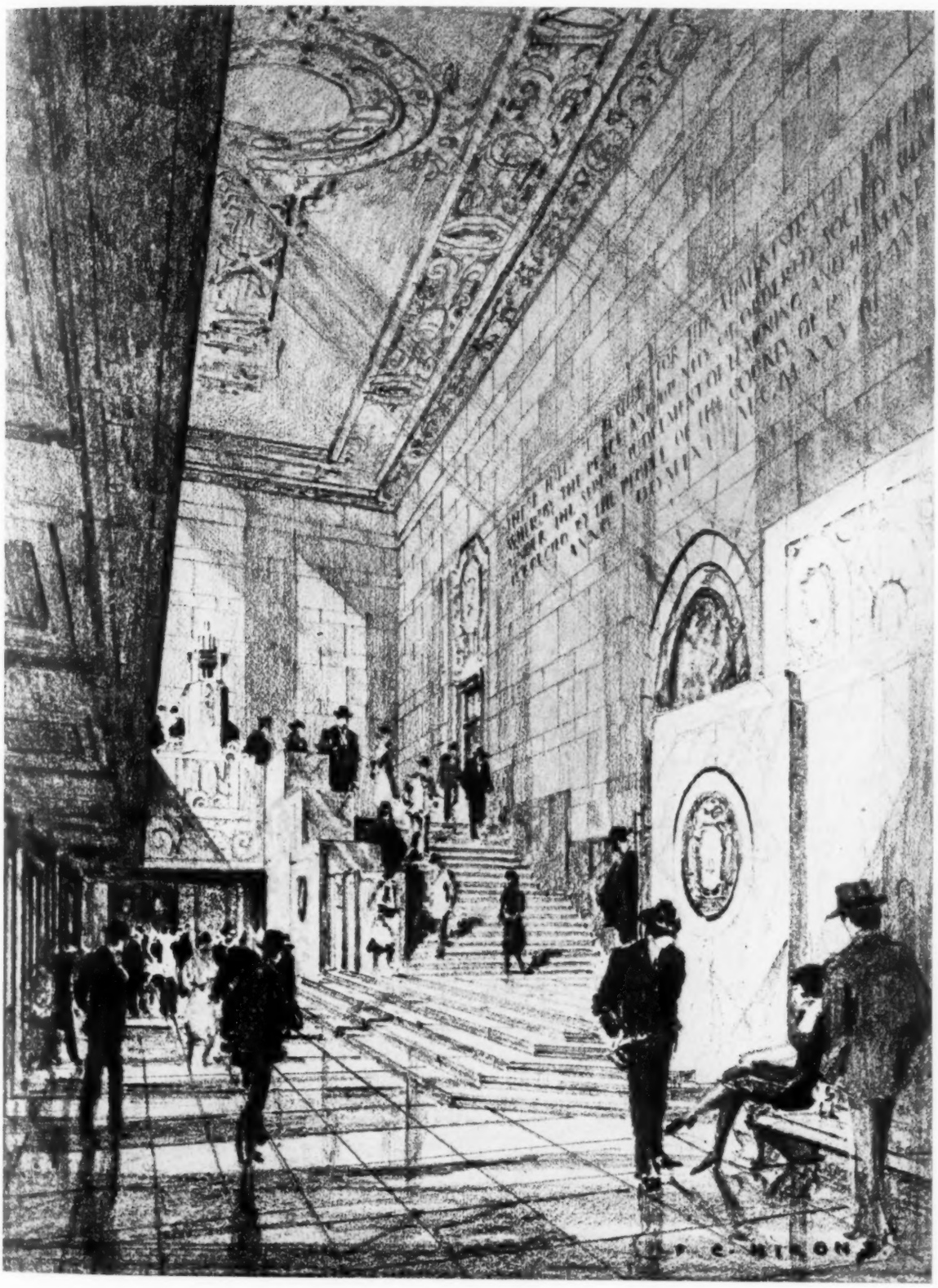
DETAIL, ROCKLAND COUNTY COURT HOUSE, NEW CITY, N. Y.
DENNISON & HIRONS, ARCHITECTS


DETAIL OF STAIRS & MARBLE WORK
PLAN AT 'B B'
SECTION CC
SECTION 'AA LOOKING TOWARD STAIRS
SECTION ON CENTER LINE
PLAN OF LIGHT MOTIVE AT VARIOUS LEVELS
ROCKLAND COUNTY COURT HOUSE

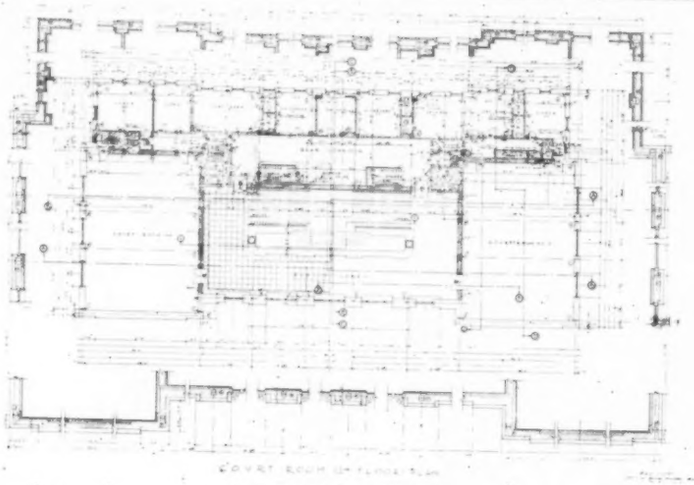
DETAILS. ROCKLAND COUNTY COURT HOUSE, NEW CITY, N. Y.
DENNISON & HIRONS, ARCHITECTS


WINDOW & G.I. PLAQUE OVER THREE MAIN ENTRANCE
ELEVATION OF GRILLES ABOVE AND DEMITRI LAMB, RIGHT ELEVATION.
GRILLES, WINDOW AND PLAQUE
MAIN ENTRANCES, FRONT ELEVATION

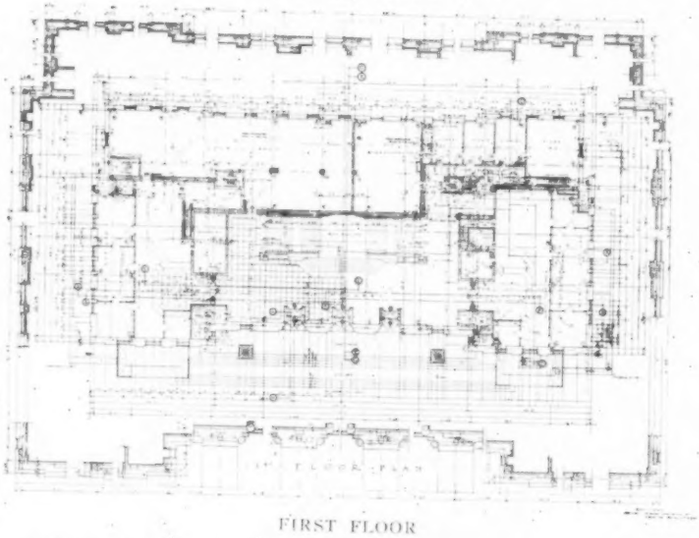
DETAILS, ROCKLAND COUNTY COURT HOUSE, NEW CITY, N. Y.
DENNISON & HIRONS, ARCHITECTS



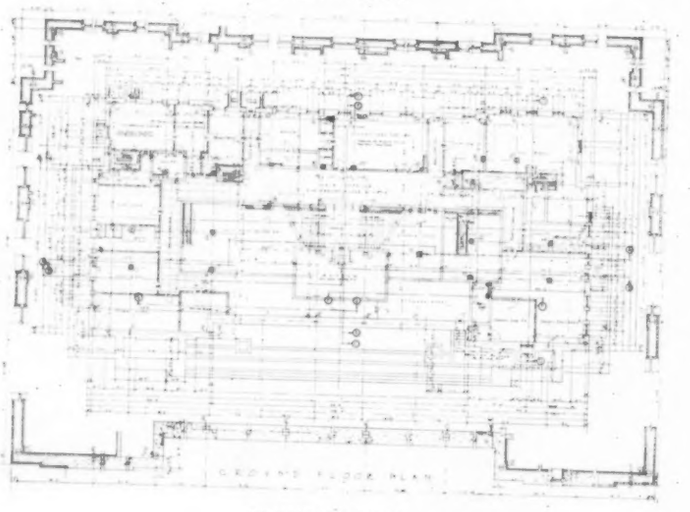
MAIN STAIRWAY
ROCKLAND COUNTY COURT HOUSE, NEW CITY, N. Y.
DENNISON & HIRONS, ARCHITECTS



SECOND FLOOR



FIRST FLOOR



GROUND FLOOR

PLANS, ROCKLAND COUNTY COURT HOUSE, NEW CITY, N. Y.
DENNISON & HIRONS, ARCHITECTS

SOME PRIORIES OF THE ELEVENTH AND TWELFTH CENTURIES

BY
MILTON D. LOWENSTEIN

ARCHÆOLOGY includes the history of a craft as well as that of an art. We can see in architectural forms a picture of an age's actual civilization. The history of other arts is often a story of unrealized aspirations. Religion, literature, painting, sculpture and music anticipate a culture. They shun the mundane and present an ideal which often guides architecture but which is not its unique *raison d'etre*. Broken walls that have withstood the ages are remains of important ethical, social or political institutions. The physical environment of the time, the mental attitude of the people and their leaders, their rituals, —not to mention their building traditions,—are all inherently a part of architecture. The modern architect who stopped to concern himself with all the influences which contributed to the building he is designing would hopelessly destroy his genius. He may, however, analyze the intricacies of another age and bring to his own time, through his art, valuable correctives. There are a few architects who understand their age intuitively, but most artists feel at some time in their careers the need of identifying themselves with a tradition and a philosophy to which they can turn for guidance and inspiration.

Through fathoming the spirit that motivated mediæval architecture, I had hoped to learn not so much that which is scholastically known as "Gothic" style as to grasp the significance of self-expression. All mediæval ruins held me enthralled when I first went to Europe. It made little difference whether it were a castle in England or a church in France,—anything which had been built between the eleventh and fifteenth centuries was a subject for study. It seemed that during this period there was fostered in all men the desire for artistic creation. In attempting to follow the example of the Creator, men in their small but nevertheless exquisite way endowed material with rare beauty. Eventually my attention narrowed down to small priories or isolated monasteries. Unlike a blatant feudal castle or a gaudy cathedral, the priory seemed to me then to constitute a living entity,—aloof, independent of life's amenities as it guarded the sacred flame of humanity from the fitful storms that swept ceaselessly over Europe. It stood for things that antedated Christianity, and it included all that was permanent and useful in western culture. Only an unsympathetic eye could behold it merely as the offspring of an omniparent basilica impregnated with oriental philosophy. The priory had less interest for me as a building than as an expression of ideals common to pagan, Jew and Christian, expressions which transient forces may obscure but which they can never obliterate.

While the Semitic tribes were wanderers, a portable Tabernacle served as a rallying place where personal succor was sought through collective intervention. When the fertile river valleys tempted the tribes to settle and build cities, there was need of law courts, houses of assembly and fortresses. The Tabernacle took over these secular functions, since it was the only place where community life had ever existed for the tribe. Similarly, the secluded citadel of pre-Christian times developed into the pagan temple when organized war for communal rights took the place of spasmodic marauding for selfish gain. The temple served as a symbol of union and as a common treasury for the more gregarious tribes against a barbaric enemy. The offerings made by individuals added to the community's benefits. The beginnings of the priory cannot be dissociated from these influences. To the idea of external propitiation of one kind or another, Christianity, through the examples of the Fathers, had suggested the possibilities of self-abnegation as a corrective for the ills besetting a sedentary civilization. But incessant warfare prevented any common endeavor or spiritual coherence. Wherever the conqueror destroyed, he rebuilt according to his own habits, as heedless of the work he demolished as he was of the brotherhood of man. Until the crusades each community interpreted St. Paul according to provincial contingencies, and church architecture was a local problem with local traditions. Still, in each priory the original, common Christian ideal was maintained unaltered.

Did the disappearance of monastic institutions imply the loss of the culture we associate with them? Or do its peculiarities form a fundamental part of human nature which has found architectural expression in other organizations?

The priory at Moret-sur-Loing had long ago been abandoned as a tannery storeroom when I first saw a corner of its well knit rubble stone wall projecting into the road. I had been sketching in the town cathedral, when a priest showed me an old print of Moret. He told me the story of its ancient glory and sad decline, and among other monuments which he said had disappeared was the Prieure de Pontloup. As I pushed open the battered wooden door, I realized that I was standing amid the ruins of the old church. After weeks of measuring and study, I completed the

The Priory at Konradsburg, from an Old Print

drawings for the restored building. This study led me into an investigation of asceticism and particularly of the lives of such men as Simeon Stylites and Benedict of Nursia. They were not the first to lift themselves above the senseless turmoil of the time. A thousand years before them Pythagoras adopted the same attitude. Then there had been the Essenes in Judæa and the Therapeutæ of Egypt.

With the founding of the Order of St. Benedict, asceticism became comprehensible to people who had regarded it with superstition or covert ridicule. A new plane of existence was revealed, an encompassing world where citizenship was based not upon tribe, nation or religion but upon a transcendent quality peculiar to the vigorous and the young. It took all of Benedict's genius to perpetuate this quality. Until his time there was no established "rule;" each group of ascetics had lived according to what seemed proper to the conditions of the time and place, but by the end of the eighth century St. Benedict's rule was known over all of western Europe. A code of 73 chapters described minutely and yet briefly the Order's life of silence, humility and obedience.

St. Benedict sought to keep the energies of his organization confined to purposes exalted enough to encompass everything worth while in life, and yet so limited as to prevent its being racked by the struggle of internecine forces. When Pope Urban II directed the eyes of Christendom to the Holy Land, many petty strifes were absorbed by the imminent single struggle. While the fiery zeal of men like St. Bernard, representatives of the one stable traditional element in Christianity, awakened the multitudes, the monasteries supplied a neutral meeting place for the allies. A fragmented society learned to appreciate the company of its neighbors in assembly and at prayers,—not to mention in times of war.

The monk took three vows. 1. *Stability;* he bound himself forever to the monastic family. 2. *Conversion;* he renounced the three concupiscences. 3. *Obedience;* the monk subjected his will to the command of a superior. Unceasing prayer kept the monk reminded of his vows and offset the temptations of self-indulgence by the refreshing experience of shared lofty emotions. People of the surrounding country joined in the more simple and obvious forms. Mass, sometimes held out of doors, like Grace dignified the day of crude physical activity and self-emolument. Monastic

Ruins of the Priory at Serabonne

labor included all the activities that took place in a small city of the time, without the arrogance which usually accompanies individual accomplishment. The monks tilled the soil, learned trades, engaged in commerce and took part in the controversies that developed from all this work. The joy of labor, having replaced the pride of achievement, demanded a form of expression. "The laborer holding the handle of the plow shall chant alleluia; the reaper drenched in sweat shall walk along singing psalms; and while the vine-dresser prunes the backbent vinestock with his sickle, he shall mumble King David's psalms." (Dom Martene. *De antiquis monachorum ritibus*). Whether rendered in set old phrases, in stone or with paint, the melody transmuted the crude material into a complement of the moment's joy. The priories, built in many instances by the monks themselves, are the most eloquent examples of this abandonment to the pleasure of workmanship and also monuments to worthy construction.

The capitals and balcony carvings in the priory of Serabonne are incomparable examples of monastic art. I came upon this little church while studying the work at St. Michael de Cuxa in the Pyrenees mountains. Accessible only by way of a mountain path, the priory is hardly known. I thought at first I would make only a few sketches of the sculpture, but I became so fascinated with this marvelous gem, set amid the bleak ranges, that I decided to make a study of the entire building. "If it should happen that a brother is enjoined with a difficult or even an impossible task, he must receive the command given him in all meekness and obedience." (*Reg, S. Bened. clxviii*). As there was no hotel within several miles, I lived in the priory, using an old coffin filled with straw as a bed. A kitchen was constructed in one of the subterranean vaults which had partially fallen through. I was reminded that food and drink supplied a sensual attraction to the novice which the monotonous tone of the "reader" in the refectory could not always succeed in overcoming when a young monk's appetite was sharpened in the keen mountain air! Benedict believed that punishment deprives the erring one of dominion over his own worldly life; that it wrests from man the noble dignity which comes from a consciousness that his soul, which he identifies with his Creator, is sole arbiter of his fate. But the compensatory nature of a man's acts, and in the case of evil their retributary character, also thwart this dominion. Through submission to a superior and through confession, the monk

sought to preserve the best part of himself and to continue in that state of grace necessary for a happy earthly existence.

The following year, accompanied by my father, I sought another example of a priory, in Germany. Near the town of Ermsleben, in the Hartz mountains, we found the remains of a twelfth century church built into an old feudal estate known as Konradsburg. The tenants seemed to be living under conditions far worse than those said to have been prevalent seven centuries ago. As we measured and sketched the ruins we obtained an unusually good picture of peasant life, and we heard those strange stories which often make the past seem far away, but which in our situation made the ancient plots live again.

Refining the technique of living is reserved for sensitive natures, who, possessing many resources, will exploit them only for a transcendent purpose. In general this means a renunciation of the greatest portion of life and, to the ordinary man, annihilation itself. Then there comes a Paul, a Bernard, or a Joan, who, by thwarting their own hidden nature, change the contemporary tendencies and bring to a focus within themselves the surging inchoate forces of a new existence for men.

In the twelfth and thirteenth centuries that part of Spain not subjected to the Moors thrived under a form of monastic leadership which depended upon the ideals of the Christian Fathers for its authority. But an institution, unlike an individual, may persist a long time after its usefulness is accomplished. When the little communities no longer needed the lesson of contented living through restraint and craftsmanship, monasticism waned but did not wholly disappear. The priory became the community church, and the prior the curate. Near the town of Reinosa there is a small mountain village called Retortillo. At the time of the year I found the priory, the peasants were cutting their winter hay. Everybody, from small tots perched atop of the loaded ox-carts and preventing the wind's blowing the hay away, to leather hided, wizened grandfathers and grandmothers who gathered the grass together as it was cut by the younger generation, took part. I first saw the rotund figure of the curate, swathed in his long black soutane, swinging a scythe with the others. It was near the hour of lunch, and he invited me to share his meal in the shade of the loaded cart while we discussed the possibility of making drawings of his little church. We finally arranged that his niece, who rode to Reinosa every morning with the milk, would stop at my hotel and carry my instruments up the mountain to Retortillo. He wanted me to ride on the little donkey too, and seemed surprised when I told him I preferred to let his niece ride!

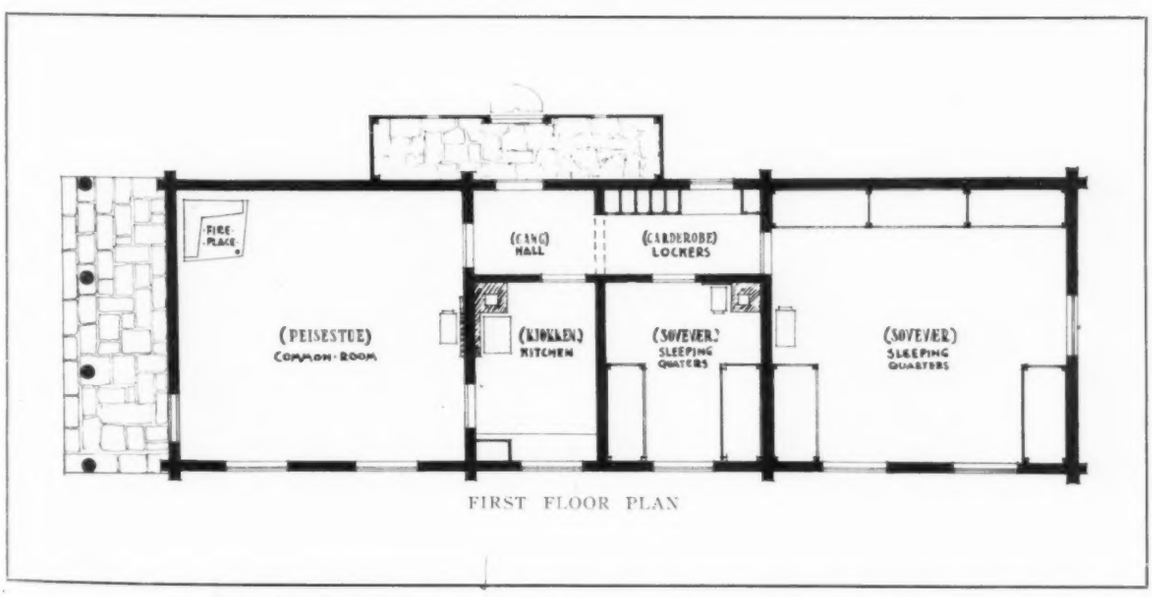
These brief accounts of the four priories,—Pontloup (Moret), Serabonne, Konradsburg and Retortillo,—are attempts to explain, through the measured drawings and archæological facts, the signifiance of the priory and its historical and sociological implications. Although the ascetic's most eloquent passages were the living moments of his life, archæology may make his ideals accessible to contemporary man. The aspirations of the Greek artist and the Hebrew prophet may be found again in them and reinterpreted by the discerning architect!

EDITOR'S NOTE. This introduction to "Studies of Certain Priories of the Eleventh and Twelfth Centuries" serves to give a slight idea of the sympathetic and understanding treatment Mr. Lowenstein has given to the subject, a subject seldom studied or appreciated by the modern architect, and yet one which should be of inspiration and value to church builders of today. It was in the monasteries and priories of mediæval Europe that the fundamental principles of the early Christian faith, as well as the remnants of the intellectual culture of the Roman Empire were preserved, after the barbarians swept down over the land and destroyed the decadent civilization of southern Europe. It was here that the literary relics of the past, including early versions of the Bible, were safeguarded, translated and rewritten. It was here that the Catholic faith was enshrined until it burst forth with renewed strength and vigor, to find visual and architectural expression in the churches and cathedrals of England, France, Spain and Italy toward the end of the middle ages. What more natural, then, that the church builders of today should be powerfully influenced by the architecture of the monasteries and priories, in which the Church itself had been preserved, and which had been given new strength, new meaning and new architectural expression? It is for this reason that THE ARCHITECTURAL FORUM has availed itself of the opportunity to publish Mr. Lowenstein's valuable discussions on four of the oldest European priories, Pontloup (Moret), Serabonne, Konradsburg and Retortillo. The introduction to these discussions, published here, clearly indicates the several spiritual and religious influences which, in Mr. Lowenstein's opinion, gave to these old priory buildings such archæological and architectural value.

Milton D. Lowenstein, who was graduated from the architectural school of Columbia University, is now in Europe engaged in special research work for the Institute of International Education. A portion of the results of this work will be published next year in THE FORUM, particularly Mr. Lowenstein's studies of the "housing problem," as solved in Europe.

THREE NORWEGIAN LOG HOUSES

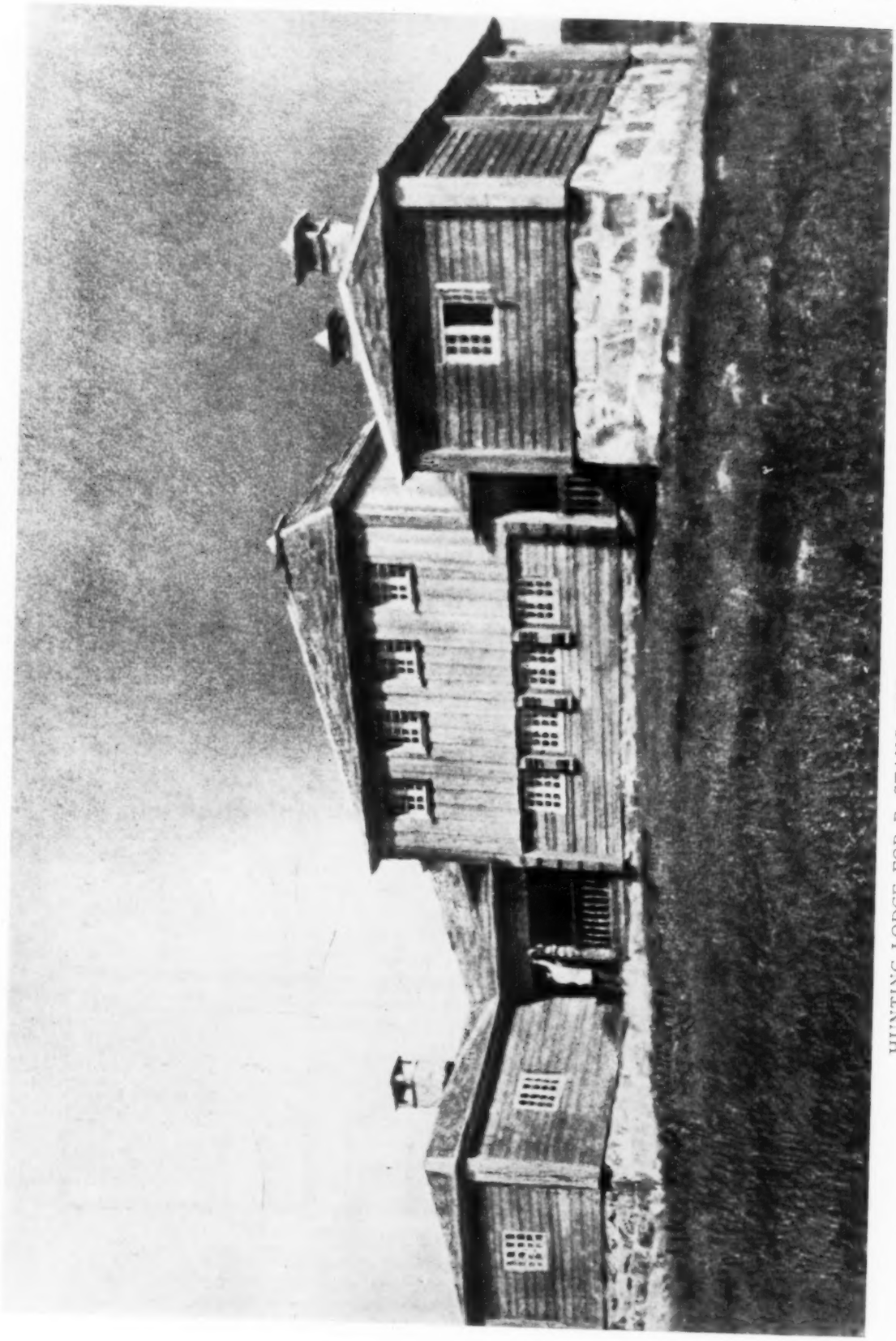
Photos, Sigurd Fischer



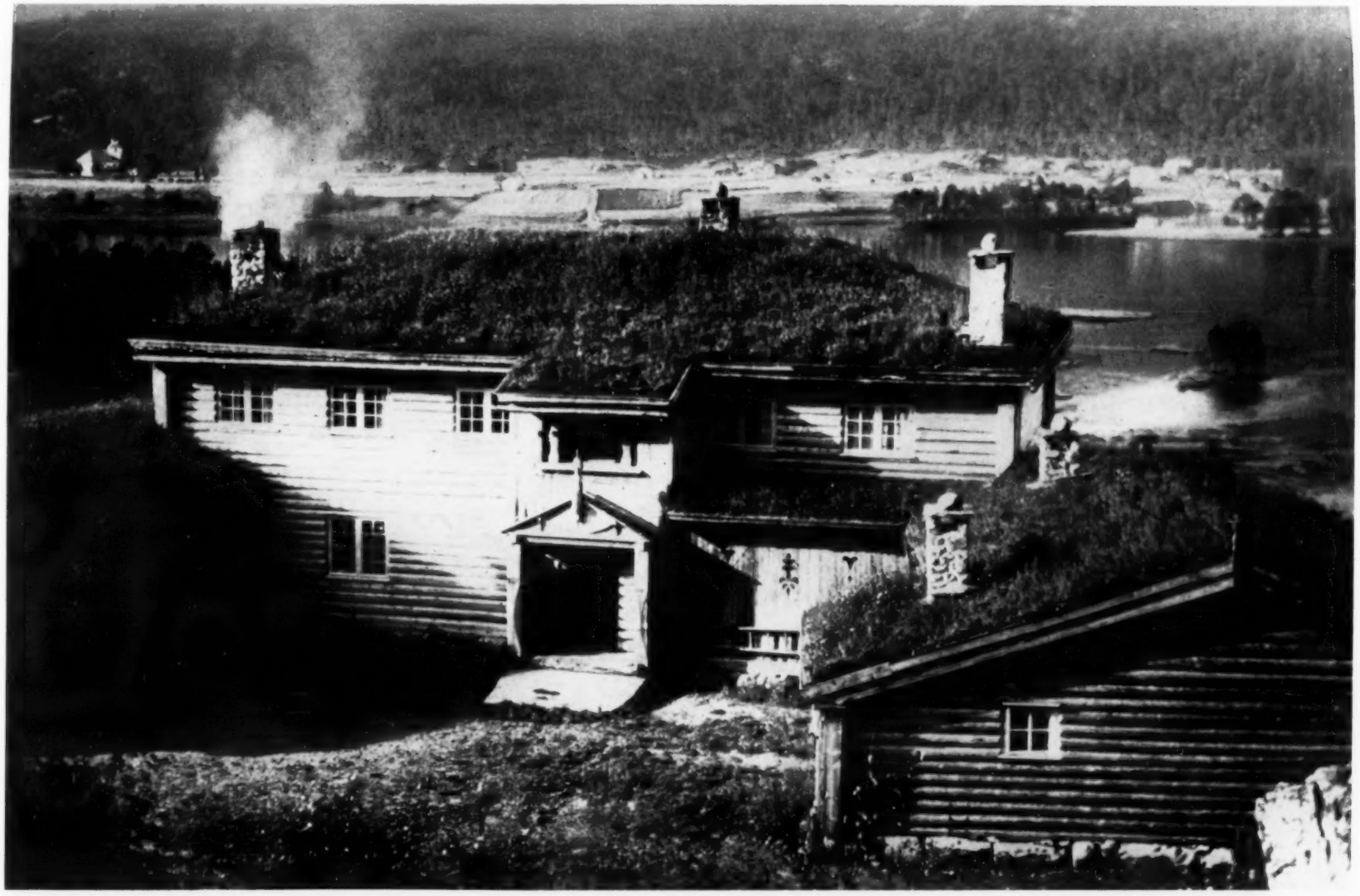
FIRST FLOOR PLAN

"SKI" CABIN FOR "SKI" CLUB, NORDMARKEN, NORWAY

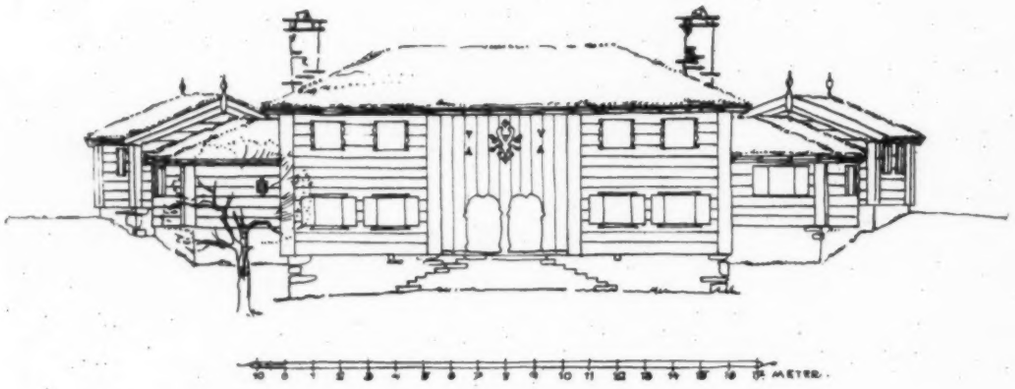
HENRIK NISSEN, ARCHITECT



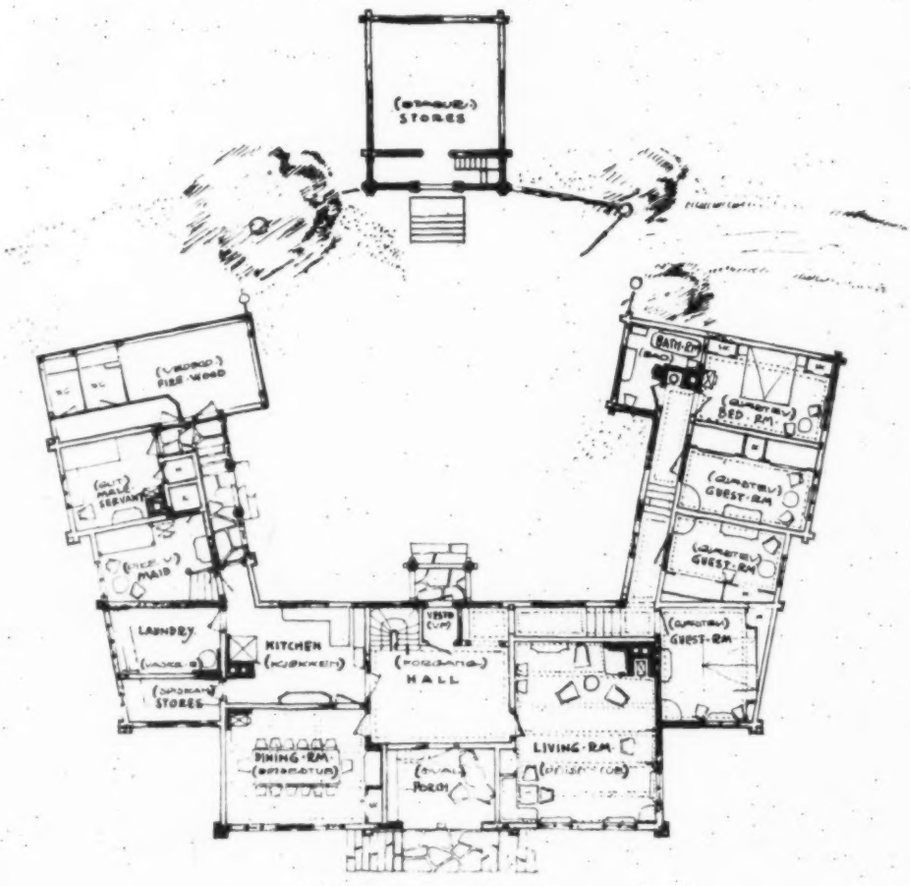
HUNTING LODGE FOR B. STANG, ESQ., SLETKOLLEN, NUMEDAL, NORWAY
MAGNUS POULSSON, ARCHITECT



MOUNTAIN HOUSE FOR EMIL STRAY, ESQ., SAETERDAL, NORWAY
MAGNUS POULSSON, ARCHITECT



SKETCH ELEVATION

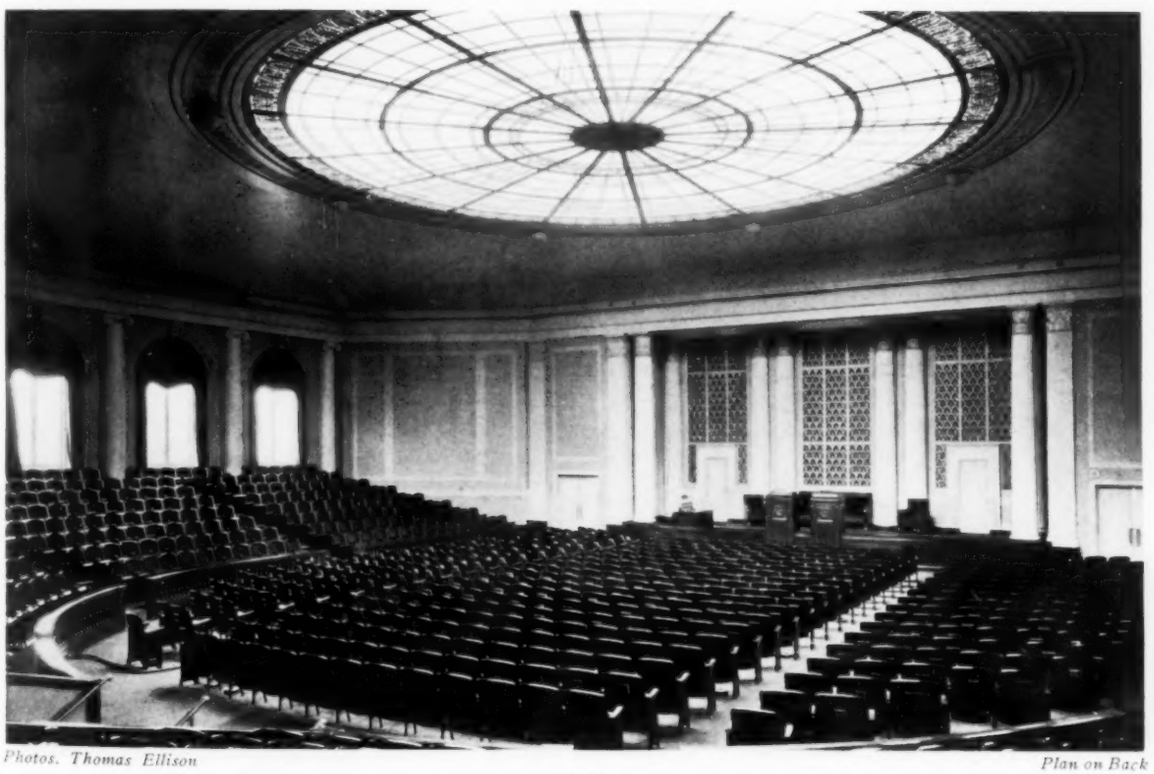


FIRST FLOOR PLAN

MOUNTAIN HOUSE FOR EMIL STRAY, ESQ., SAETERDAL, NORWAY

MAGNUS POULSSON, ARCHITECT

GENERAL VIEW

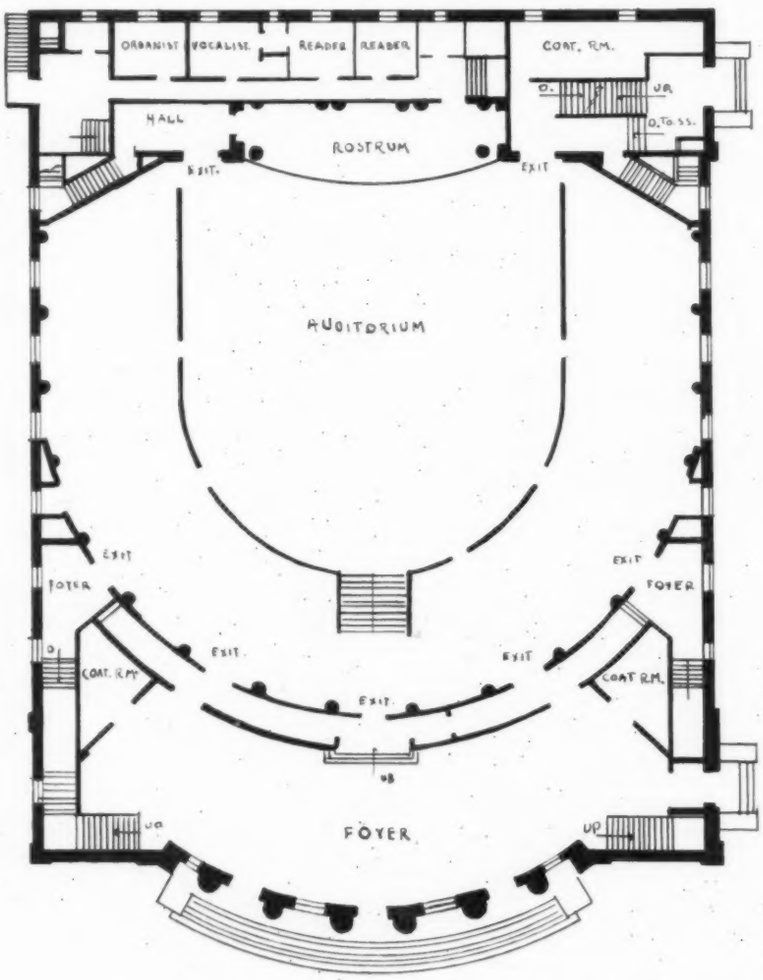


Photos. Thomas Ellison *Plan on Back*

INTERIOR

THIRD CHURCH OF CHRIST, SCIENTIST, DETROIT

GEORGE D. MASON & CO., ARCHITECTS

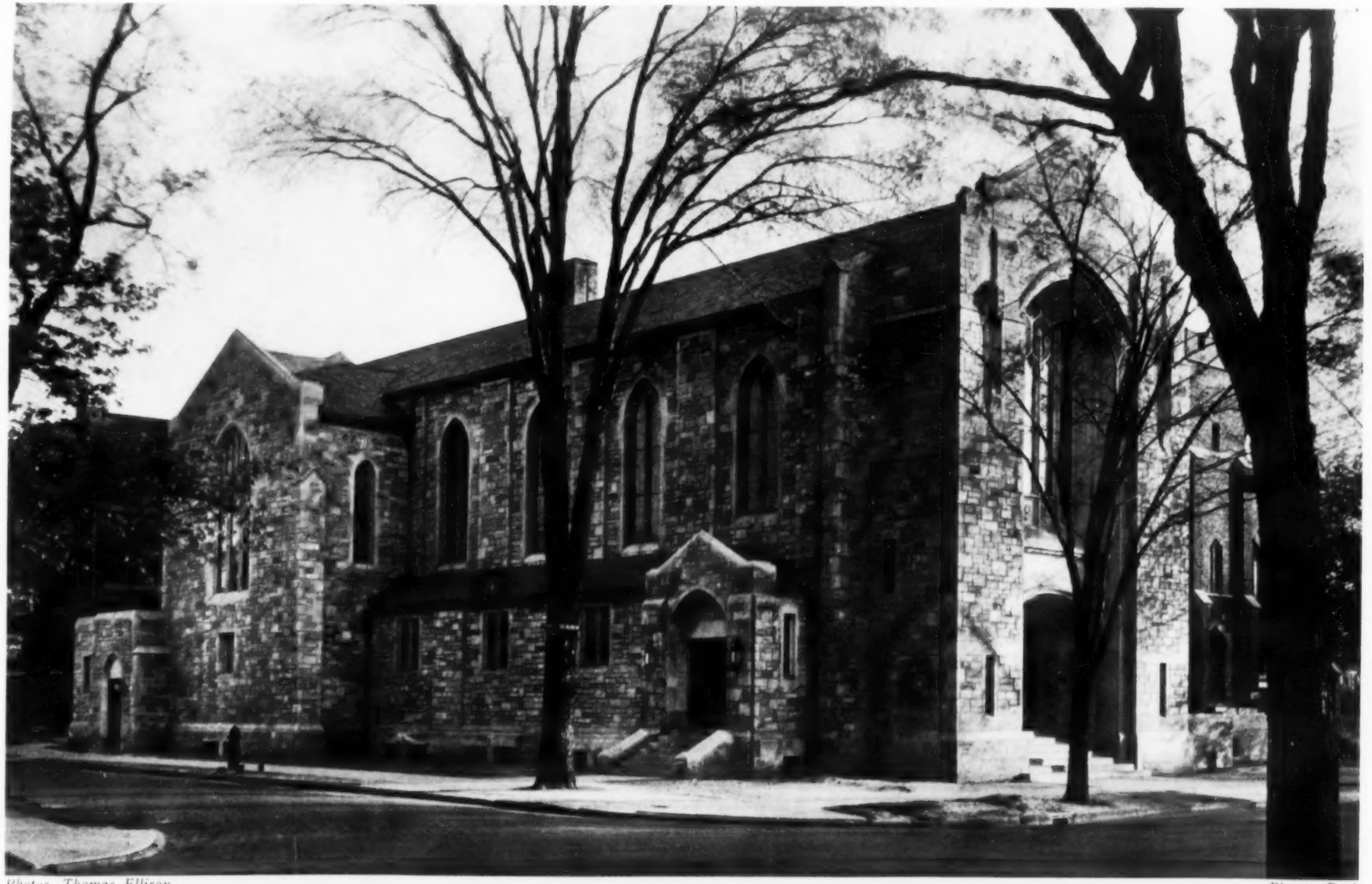


FIRST FLOOR

PLAN. THIRD CHURCH OF CHRIST, SCIENTIST, DETROIT

GEORGE D. MASON & CO., ARCHITECTS

MAIN FACADE
THIRD CHURCH OF CHRIST, SCIENTIST, DETROIT
GEORGE D. MASON & CO., ARCHITECTS

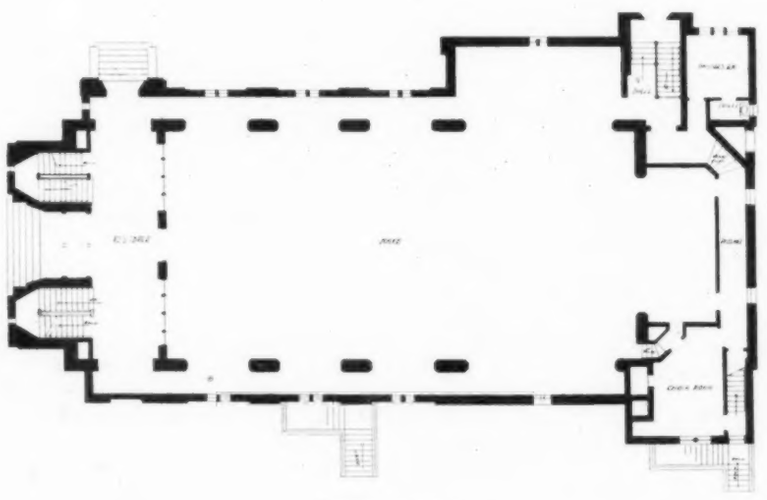


Photos. Thomas Ellison *Plan on Back*

GENERAL VIEW

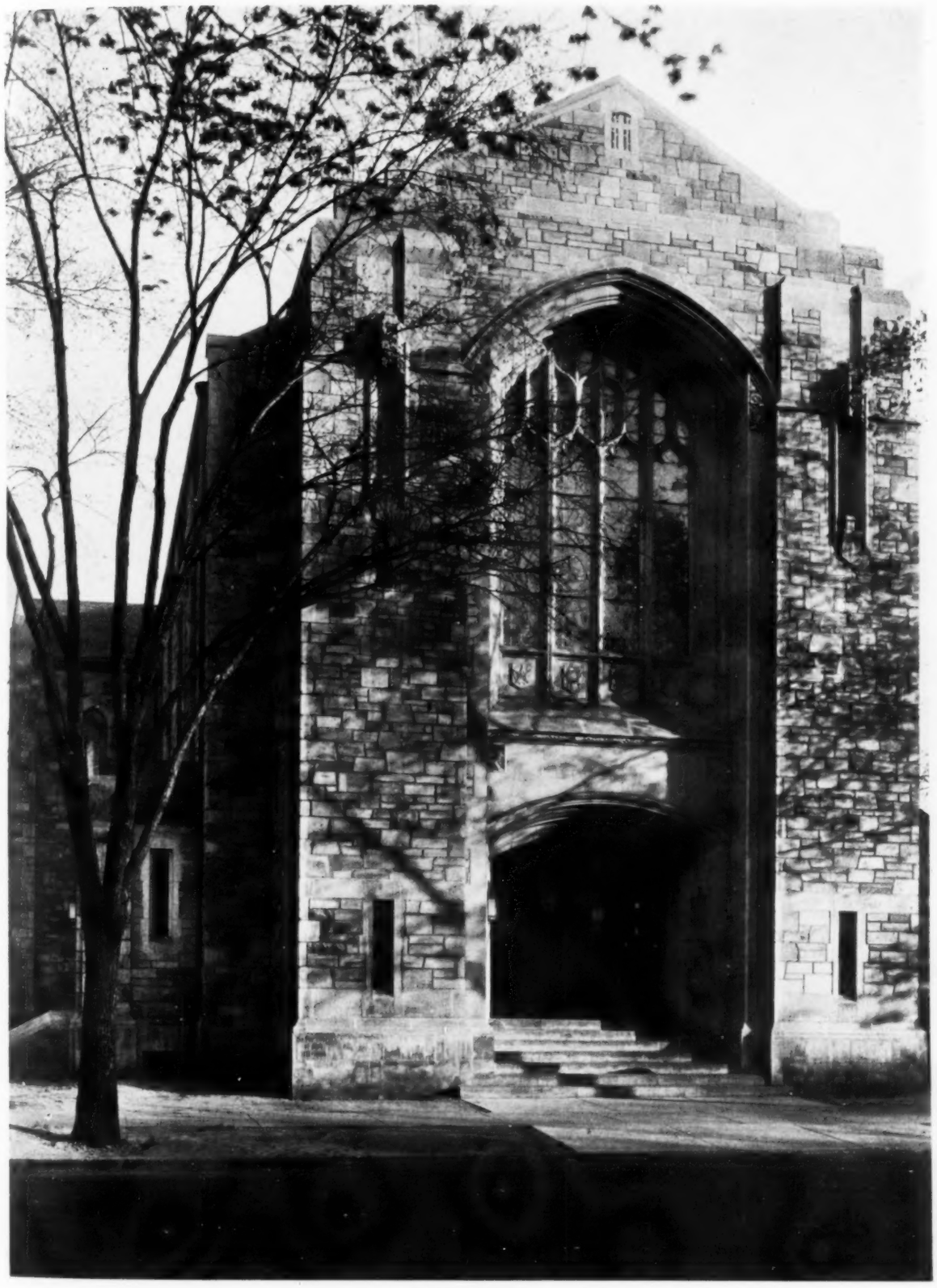
PRESBYTERIAN CHURCH OF THE REDEEMER, DETROIT

GEORGE D. MASON & CO., ARCHITECTS



FIRST FLOOR

PLAN. PRESBYTERIAN CHURCH OF THE REDEEMER, DETROIT
GEORGE D. MASON & CO., ARCHITECTS

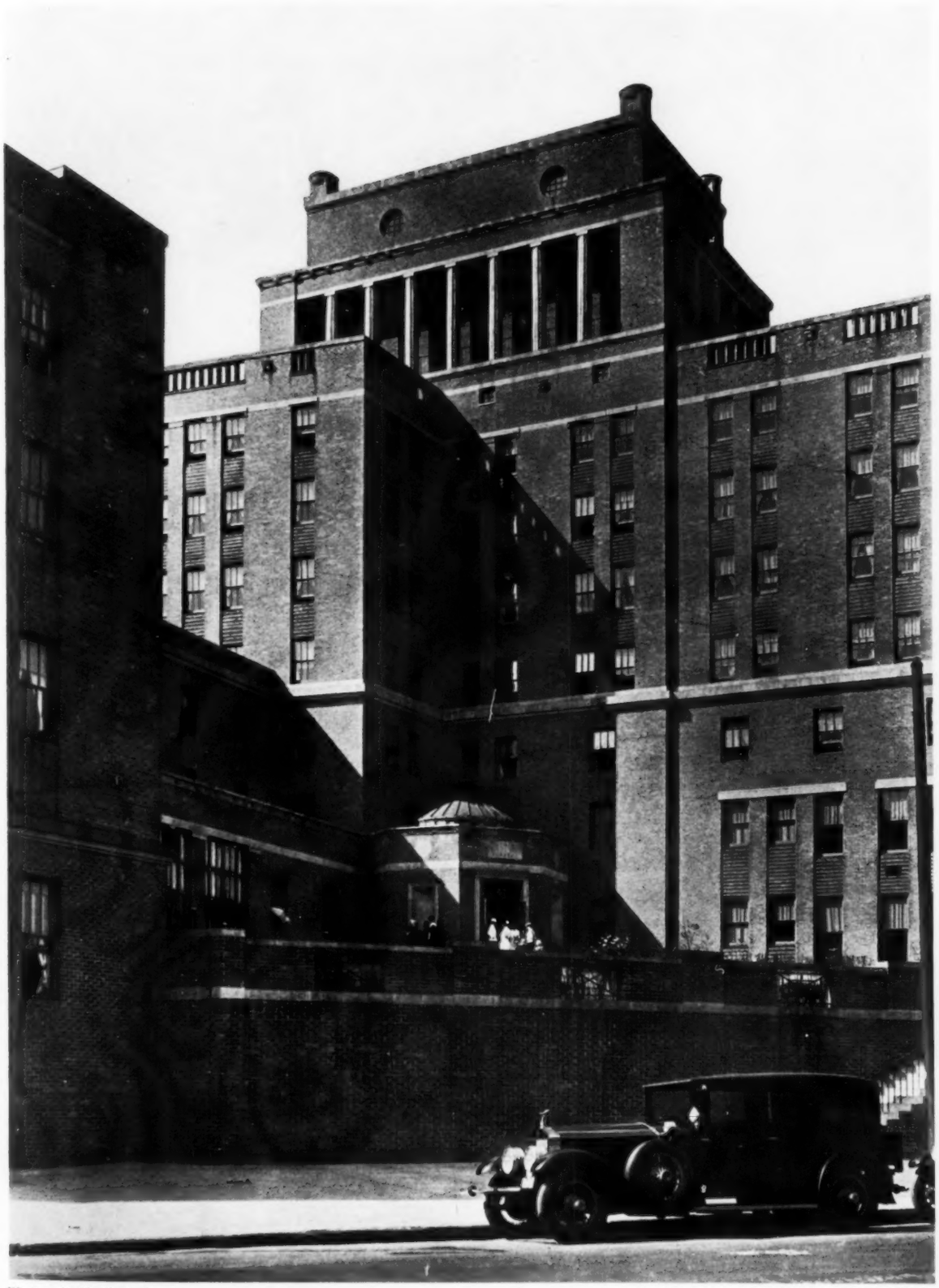


WEST FRONT

PRESBYTERIAN CHURCH OF THE REDEEMER, DETROIT

GEORGE D. MASON & CO., ARCHITECTS

INTERIOR
PRESBYTERIAN CHURCH OF THE REDEEMER, DETROIT
GEORGE D. MASON & CO., ARCHITECTS

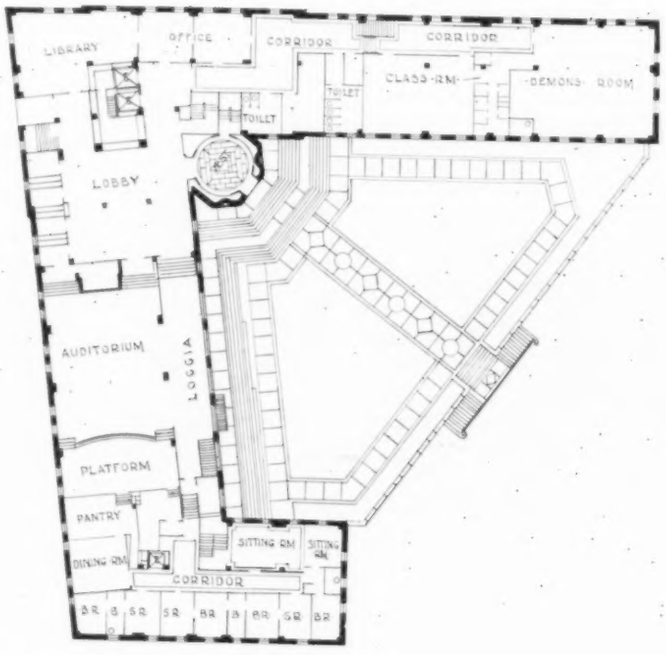


Photos. S. H. Gottscho

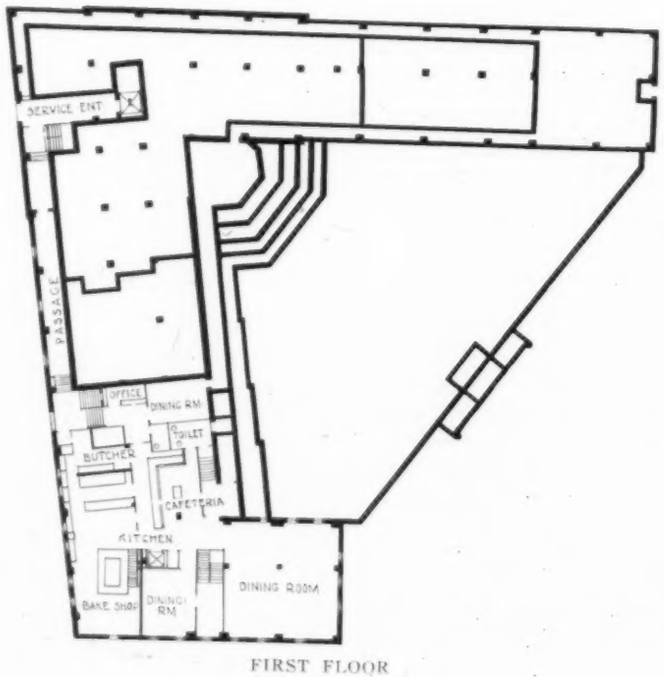
LINCOLN SCHOOL FOR NURSES, NEW YORK

PENNINGTON & LEWIS, INC., ARCHITECTS

Plans on Back



SECOND FLOOR



FIRST FLOOR

PLANS, LINCOLN SCHOOL FOR NURSES, NEW YORK
PENNINGTON & LEWIS, INC., ARCHITECTS

GENERAL VIEW

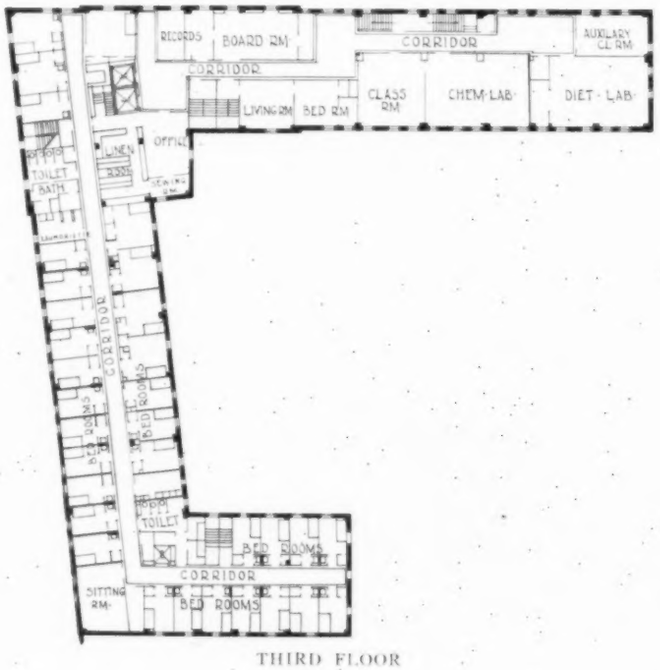
VIEW FROM 141st STREET

Plans on Back

LINCOLN SCHOOL FOR NURSES, NEW YORK

PENNINGTON & LEWIS, INC., ARCHITECTS

FIFTH, SIXTH & SEVENTH FLOORS



THIRD FLOOR

PLANS, LINCOLN SCHOOL FOR NURSES, NEW YORK
PENNINGTON & LEWIS, INC., ARCHITECTS

AUDITORIUM

LOBBY

LINCOLN SCHOOL FOR NURSES, NEW YORK

PENNINGTON & LEWIS, INC., ARCHITECTS

THREE GARDENS AT GROSSE POINTE, MICH.

RUTH DEAN, LANDSCAPE ARCHITECT

BY
ANNE LEE

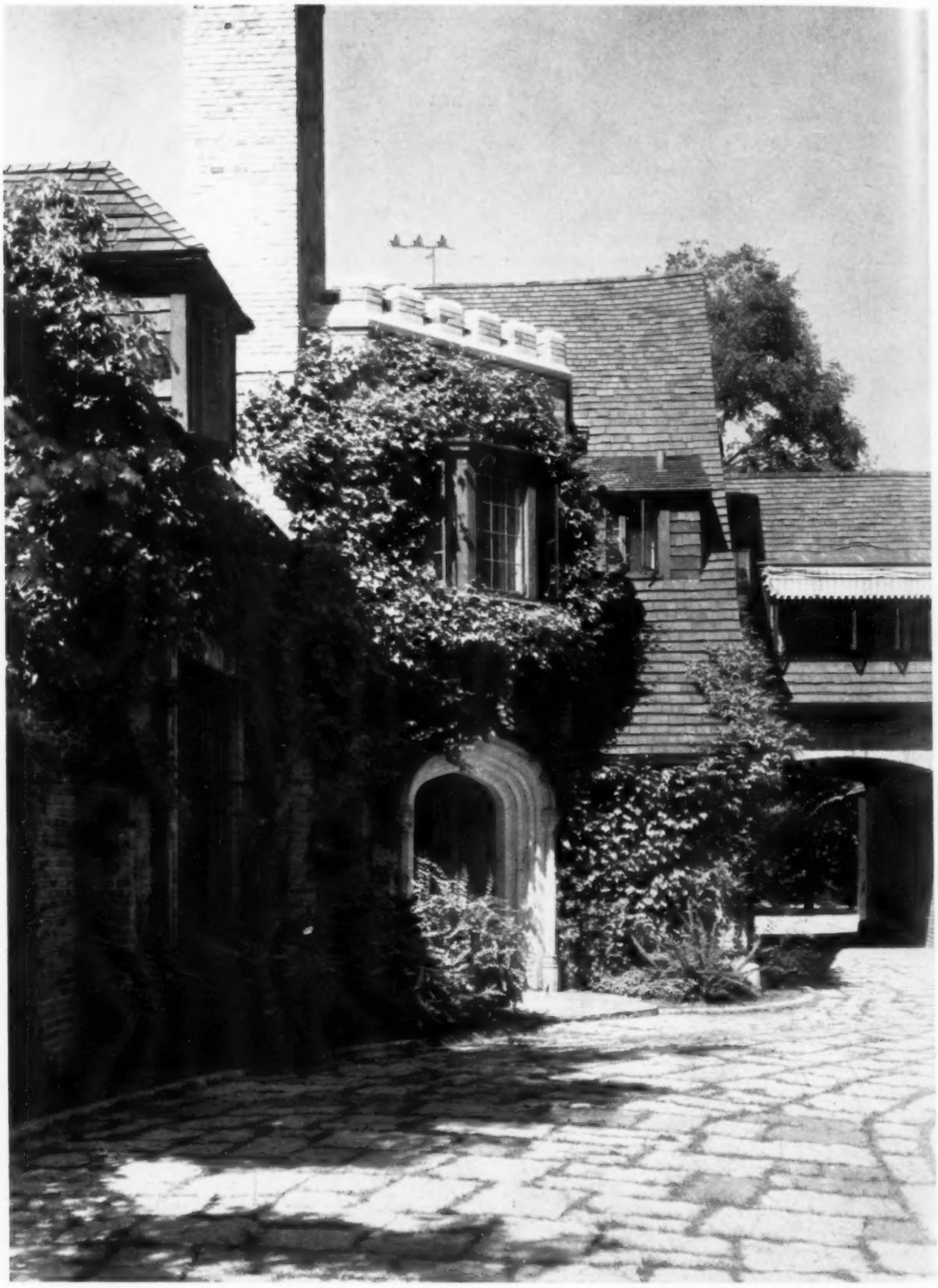
AWARDED The Architectural League's 1929 Medal of Honor in Landscape Architecture, Ruth Dean is the first woman to achieve this distinction. Although the award was made for three Grosse Pointe, Mich., gardens, it may be assumed that the background and professional prestige of the contestant were duly considered along with the specific gardens for designing which the medal was bestowed. The precedent established by this recognition of a woman landscape architect no doubt lends encouragement to the increasing number of women engaged in that profession. Sixteen years of independent practice, following her training at the University of Chicago and varied experience in both architecture and landscape work here and abroad, have given Miss Dean every type of landscape problem to solve. Her commissions have included developing tiny plots as well as small and large estates in various parts of the country, and the results have earned for her a name for successful work in the planning and planting of gardens. Due to her knowledge of architecture, this landscape architect has also acquired a habit of thinking in terms of architecture, of working with the two-fold purpose of creating a garden that is not only beautiful in itself but that affords a proper setting for the specific house to which it belongs.

The medal-winning Grosse Pointe gardens exemplify the diversity of Miss Dean's landscaping. Two of the three gardens,—those of Mrs. Howard Bonbright and Ledyard Mitchell,—are somewhat architectural in plan although informal in feeling, whereas the third,—that of Hiram Walker,—is distinctly naturalistic. The former two, each consisting of an acre or a bit less, illustrate the possibilities of this popular sized plot. So designed that they afford considerable privacy and adequately meet the needs of their owners, these gardens are examples of securing the maximum utilization of comparatively small areas. Restfulness has been achieved by means of a well balanced relationship between open stretches of lawn and luxuriant planting in the one case, and in the other between large, old trees and beds of perennials. Grass paths, pools and effective brick walls are features of both gardens.

Somewhat unusual in plan is the Bonbright garden. The fan-shaped arrangement met the client's desire to have the garden afford an effect

Photos. Tebbs & Knell, Inc.

Careful Planting of Perennials, With Grass Paths, Produces Interesting Effects in the Hiram Walker Garden
Ruth Dean, Landscape Architect



VIEW OF THE HOUSE OF HIRAM WALKER, ESQ., SHOWING TERRACE AND PLANTING IN COURTYARD

RUTH DEAN, LANDSCAPE ARCHITECT

VIEW FROM THE HOUSE OF HIRAM WALKER, ESQ., SHOWING THE PRIVACY OF THE GARDEN

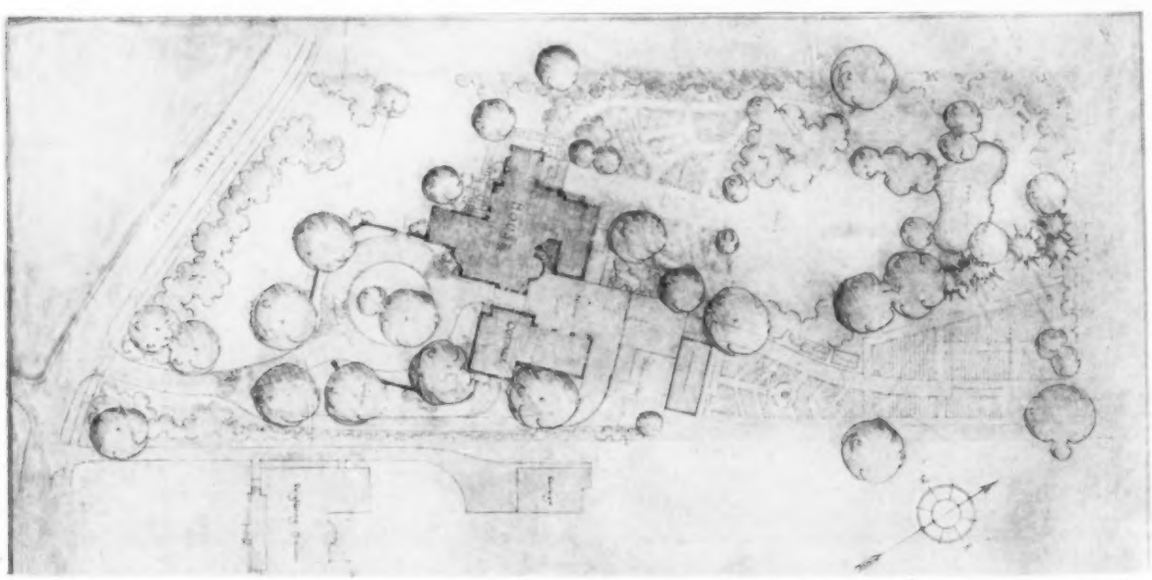
RUTH DEAN, LANDSCAPE ARCHITECT

Although the Illustration Shows the Concrete Rim of the Pool, Which Was Not Entirely Filled, It Was So Built That Grass Could Be Grown to Meet the Water Line Without Showing Concrete

Limestone Slabs Give the Pool a Picturesque Effect with Water Spilling Over Stones from an Upper Level to Give the Effect of a Natural Spring-fed Pond

Garden of Hiram Walker, Esq.
Ruth Dean, Landscape Architect

of spaciousness and at the same time seem intimately related to the terrace. This was accomplished by keeping the main axis open and by using side paths that radiate from the terrace. To lend an effect of distance, hawthorn trees were placed in front of the pool, one on each side of a path wide enough to permit a view and give depth. Due to the square-shaped plot, the landscape architect found it necessary to secure an effect of depth entirely by means of planting. There was



Sketch Plan. Garden of Hiram Walker, Esq.
Ruth Dean, Landscape Architect

Flower Beds in the Garden of Hiram Walker, Esq.
Ruth Dean, Landscape Architect

little or nothing available in the way of trees to begin with. To block out a rather high brick house on the adjoining property, it was necessary to depend upon heavy planting to give seclusion.

In the Mitchell garden, the red brick wall, built with piers and capped with flagstones, serves as a background for vines, primroses, ferns, Canada lilies, plantain lilies, Solomon seal, snakeroot and violets, these plants having been used because of the amount of shade thrown by the splendid, old large maples and because of the fact that they take so much nourishment from the soil.

The Walker garden,—which shows the most ingenious planning and is perhaps the most interesting of the three,—comprises about four acres. With a frontage of only 250 feet and a depth of 500 feet on one side and 800 feet on the other, the plot presented something of a problem. The existence of number of large elms and native hawthorns suggested adopting the naturalistic style of treatment. So successfully was it carried out that the visitor is inclined to give to nature the credit which really belongs to the landscape architect. Referring to this garden, Miss Dean spoke of it as an ideal operation on which to work. The beauty of the piece of land, a sympathetic client and a most coöperative architect combined to make it so. From the time the first sketches for the house were drawn, Miss Dean worked with the architect. Together they decided upon the location of the house. Making a detailed survey of the land, they experimented with a small, scaled model of the house to determine the most desirable building site,—a location which would assure privacy from neighboring houses and the most advantageous outlook from the principal rooms. Besides accomplishing those objectives, they so placed the house among the trees that they appear to enfold it. The plan included here shows the effective arrangement of the vegetable, herb and flower gardens, the latter with irregularly shaped beds and grass paths. There is a wide grass lane through the vegetable garden, which was carefully planned with cut flower borders to edge the paths and with a grape arbor at the far end to help frame it. A large, irregularly shaped swimming pool set among the trees at the rear of the plot is one detail of the Walker garden. In its successful naturalistic effect, there is no hint of the conscientious effort that was made to have it appear that the pool was the work of nature. Excavation for the concrete tank provided earth for a rise in the land at one end, the level of which is 4 feet higher than the pool level. By lining that end of the pool with slabs of mellow-toned limestone, only the weathered edges of which are exposed, and by piping the water to the top of the rise so that it spills over the stones into the pool, the effect is that of a natural spring's being the source of supply. This naturalistic effect was further heightened by building the concrete tank so that earth could be

VIEW OF GARDEN FROM THE TERRACE, SHOWING LARGE OPEN SPACE IN CENTER WITH PATHS AT THE SIDES

A PLAYGROUND IS LOCATED AT ONE END OF THE PLOT; GARDEN OF MRS. HOWARD BONBRIGHT

RUTH DEAN, LANDSCAPE ARCHITECT

A LONG GRASS PATH BETWEEN BEDS OF PERENNIALS LEADS TO THE POOL IN THE GARDEN OF LEDYARD MITCHELL, ESQ.
RUTH DEAN, LANDSCAPE ARCHITECT

Two Views of the Garden of Mrs. Howard Bonbright
Ruth Dean, Landscape Architect

placed over the receding rim in order that grass might be grown to the edge of the water line. Due to the fact that the tank had not been entirely filled when the pool was photographed, the rim is visible in the two illustrations shown on page 508.

Wild prairie roses and wild grape, banked behind the pool so that their branches fall naturally over the stones, add to the effectiveness of the setting. The springboard is placed between beds of mint. Locust logs form the steps leading to the rise, where a rustic seat placed amid luxuriant foliage affords a secluded spot. The planting there includes shadbush, black alder, arrow-wood, hawthorns, ironwood, and some bittersweet. Elders, white birches, beeches, elms and oaks are to be found among the trees behind the pool. To approach the swimming pool from the house, one may take either of the two paths leading from the paved area outside the dining terrace. The narrow grass path separates beds of perennials, luxuriant with bloom throughout the seasons, from tulips to chrysanthemums. Skirting a clump of trees, including large existing sycamores, lindens and a hawthorn, this path rambles through a delightfully wild retreat, where plant life native to that region is allowed to grow in profusion amid numerous trees that make the spot a woodland nook. The planting there includes snakeroot, baneberry, wild asters, beebalm, Solomon seal, wild columbine, lady slippers and several varieties of native ferns. There are witch-hazel, high bush cranberry and ninebark shrubs, and the trees include the white pine, bird cherry, elder and Judas. The other path is a broad grass lane that runs past the rose garden to the large, beautifully kept lawn, across it and through the trees to the pool. Both paths were planned to lend pleasant vistas from the dining terrace. Several large elms are so situated on the property that shadow effects on the lawn are lacy and interesting, the landscape architect having made an effort to avoid too much solid black in the shadows. Proper placing of trees will produce shadows to break a plain stretch of lawn, and that was kept in mind.

Among its other charms, the Walker garden has the effect of spaciousness and the privacy achieved by the planning as foremost factors. Because of the shape of the property, this accomplishment is especially noteworthy. Work on this estate was begun in 1925, some of the planting having been done before the house was commenced. Since its completion the next year, Miss Dean has been called in to make an inspection and submit a report on the condition of the garden each spring and fall, her recommendations being carried out by the gardener. This may be another reason why the landscape architect refers to the Walker garden as "an ideal commission," —another reason, perhaps, why it helped win the Medal of Honor awarded to Miss Dean by The Architectural League at the Architectural and Allied Arts Exposition held in New York in April

THE BALDWIN LOCOMOTIVE WORKS OFFICE BUILDING

SIMON & SIMON, ARCHITECTS

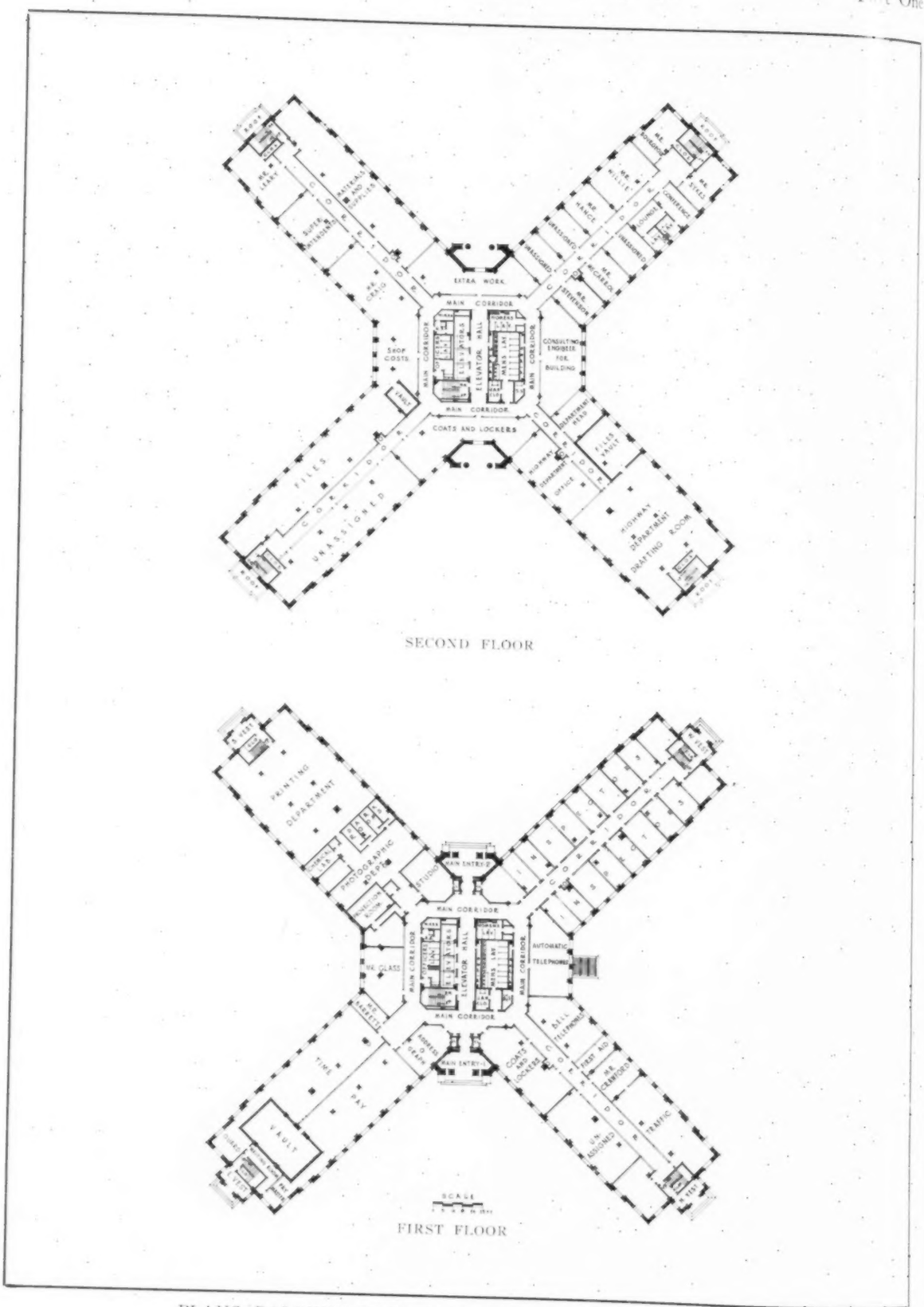
WHEN the management of the Baldwin Locomotive Works decided to transfer its entire plant and general offices from an intensely developed 20-acre location in central Philadelphia to a new 600-acre site in Eddystone, the housing of the executive, administrative, engineering and clerical departments presented a special problem. In order that the solution might be made with the benefit of thorough study and professional knowledge, this problem was turned over to an architectural and engineering organization. After research in the subject, the architects drew up a program for the project.

The unusual form which the building assumed in the solution of this program can be best explained through a summary of the preliminary study. From the clients the architects obtained statistics from which graphs were prepared showing the sales and volume of the company's manufacture as well as the number of its employes over a period of years. An analysis was made of the present organization, beginning with an organization chart and ending with a study of areas and personnel by departments. A questionnaire designed to determine the future activity of departments was submitted to the management, and its findings were tabulated and compared with a similar estimate made by the architects, their study being based on present maximum, and probable future criteria for each department. From these it was possible to determine the area necessary for the personnel to be accommodated and the spacial requirements for each department. The ideal department location was considered in relation to the building and also to other departments, including the manufacturing plant. From the inter-departmental studies the subjects of entrances and circulation areas were given consideration.

As the land was of only moderate value, it followed that the building might take whatever shape or area its program required. Block plans of different shapes were analyzed with reference to ratio of net to gross areas, maximum travel across the building and the length of enclosing walls. The Greek cross plan selected showed a gross area of 25,500 square feet of which 85 per cent was net usable area as compared with 28,600 square feet with 68 per cent net for a hollow square plan and 27,500 square feet with 80 per cent net for an "H" plan. The maximum travel across the building for the three schemes was 256 feet for the cross, 272 feet for the hollow square, and 360 feet for

Photos, Richard T. Dooner

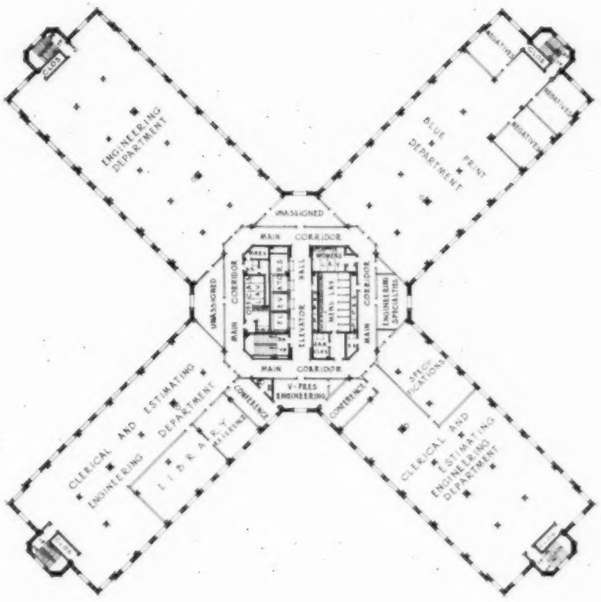
√ Baldwin Locomotive Works, Eddystone, Pa.
Simon & Simon, Architects



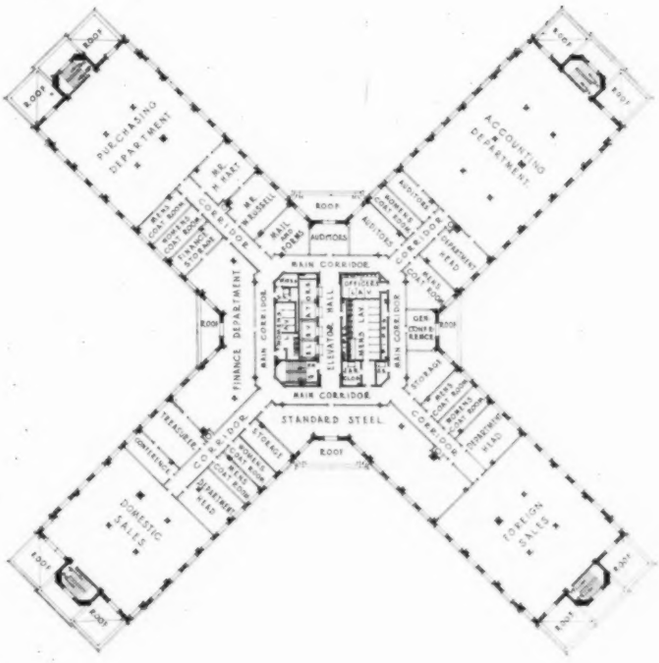
SECOND FLOOR

FIRST FLOOR

PLANS, BALDWIN LOCOMOTIVE WORKS, EDDYSTONE, PA.
SIMON & SIMON, ARCHITECTS

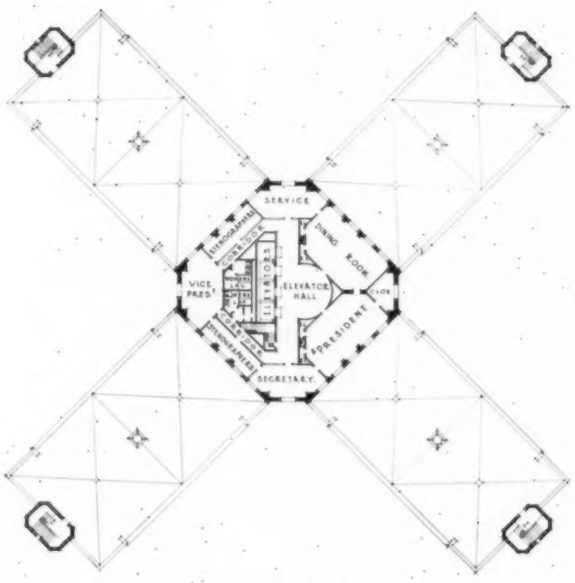


FOURTH FLOOR

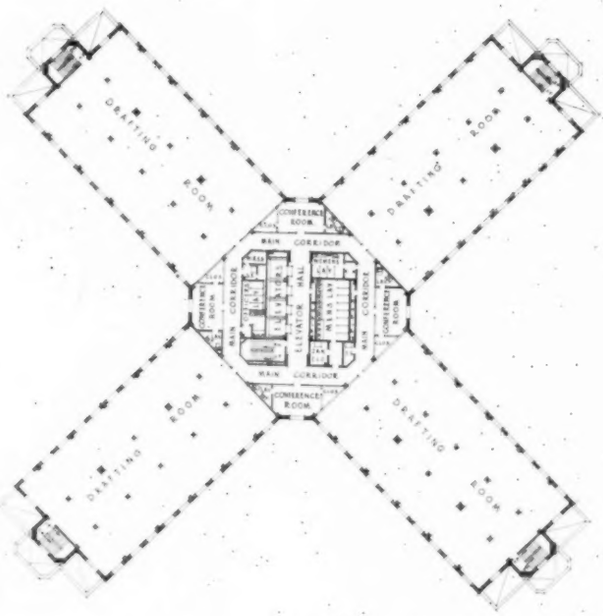


THIRD FLOOR

PLANS, BALDWIN LOCOMOTIVE WORKS, EDDYSTONE, PA.
SIMON & SIMON, ARCHITECTS

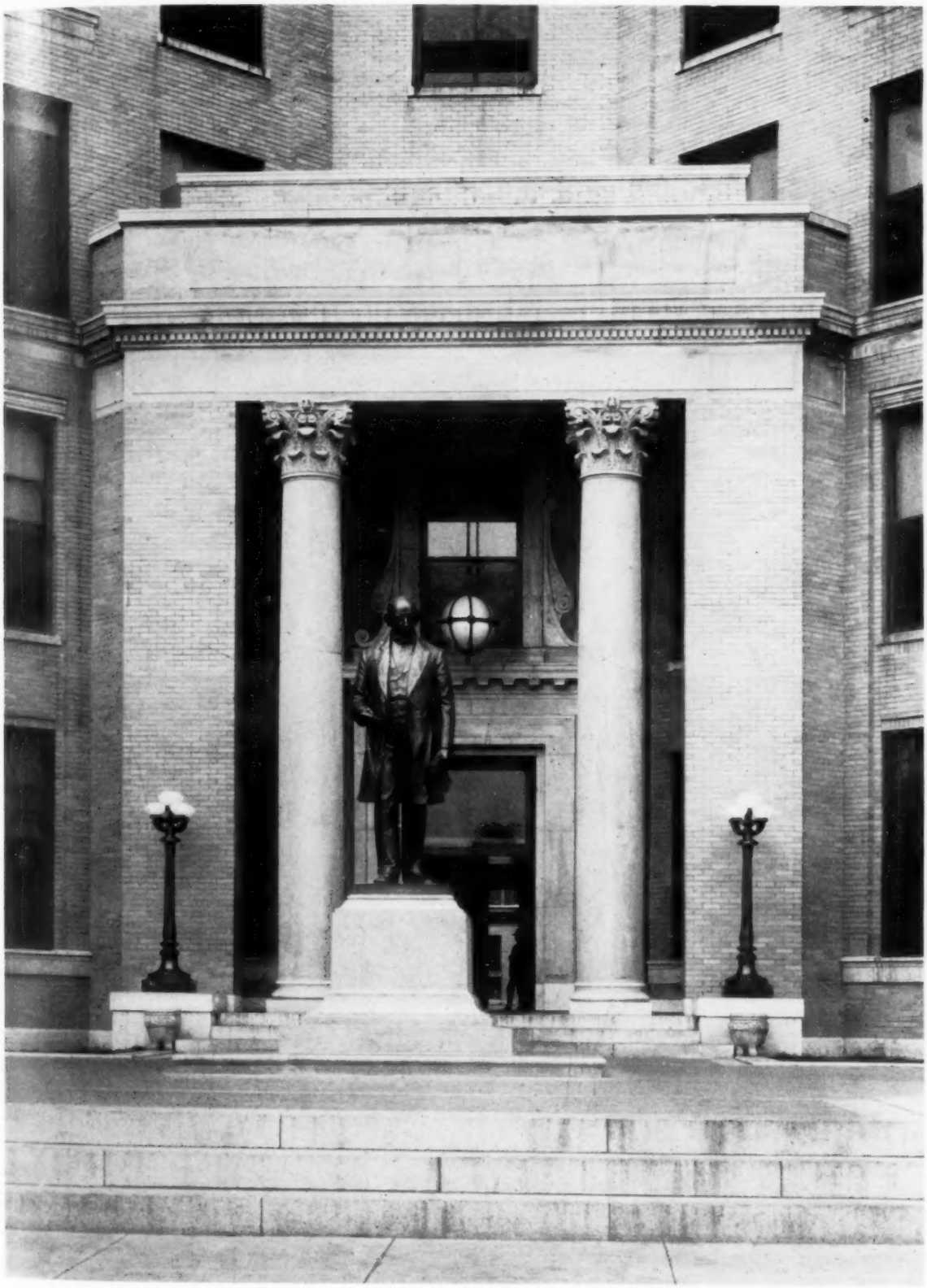


EIGHTH FLOOR AND ROOF



FIFTH, SIXTH AND SEVENTH FLOORS

PLANS, BALDWIN LOCOMOTIVE WORKS, EDDYSTONE, PA.
SIMON & SIMON, ARCHITECTS



MAIN ENTRANCE
BALDWIN LOCOMOTIVE WORKS, EDDYSTONE, PA.
SIMON & SIMON, ARCHITECTS

the "H" plan. The advantages of natural light and ventilation given by the cross plan presented additional points in its favor. It also affords the desirable relationships of departments, supplies centralized access and communication by a convenient grouping of elevators, and gives a positive control of traffic throughout the building.

The arrangement of the floors follows the requirements of the program. The first floor is devoted to those departments which the shopmen have most occasion to use,—the inspection, transportation, time and pay departments. The second floor houses the officials and staffs which have supervision of manufacturing and plant maintenance. On the third floor are located foreign and domestic sales, the purchasing, financial and accounting departments. From the fourth to the seventh floors inclusive are housed the engineering department and drafting rooms, with the engineering executive offices and the sections for estimating, specifications, blueprinting and engineering clerical work on the fourth. The general executive suite, on the eighth floor, contains the Eddystone offices of the president, secretary and treasurer, with their clerical staffs.

Foundations rest on concrete caissons carried down to rock. The structure is of fireproofed steel, the exterior veneer being of brick and terra cotta with the entrance detail of granite. The depth of the wings of the building is 52 feet, 11½ inches, and the length from extremity of wing to extremity of opposite wing is 315 feet, 6 inches. The total usable or office floor area exceeds 154,000 square feet, and the gross floor area, including building utilities, stairways, corridors, lobbies and elevator shafts, is slightly in excess of 200,000 square feet. The principal entrances are two in number, in the northeast and southwest re-entrants between wings of the building. Additional access for emergency use is provided by four stairways, with outside exits.

The mass of the structure developed in an interesting manner, as departments were superimposed one upon another. From the first floor, accommodating the general shop departments, up through the other departments to the executive offices in the top of the central tower, the allotment of the required space has led to floors of diminishing areas, which results in use of the pyramidal or "set back" form of composition.

President's Office
Baldwin Locomotive Works, Eddystone, Pa.
Simon & Simon, Architects

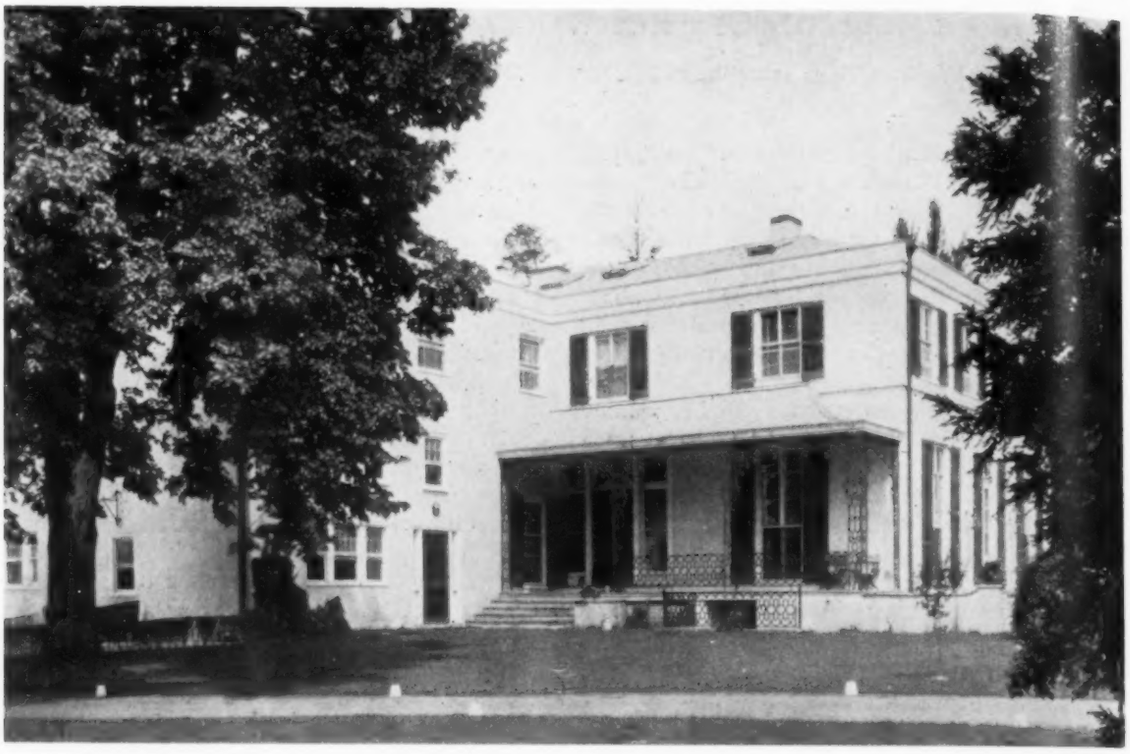
RESTORATION OF "KENWOOD," A REGENCY HOUSE

LEIGH FRENCH, JR., ARCHITECT; HAROLD D. EBERLEIN, ASSOCIATED

AT Bethayres in the Huntingdon Valley just outside of Philadelphia, "Kenwood," is a country house recently remodeled and added to for the fourth time within a century and a quarter. In its present form it is also a restoration to the manner indicated at the first remodeling about 1810, a manner more or less in accordance with which the two next changes and enlargements were carried out about 1830 and 1840. This manner, in spite of the debased form of a waning tradition in vogue at the date of the last named structural change, and in spite of sundry later Victorian mutilations, was still evident enough to suggest the course for the work recently completed. It is of interest to note that wherever demolition became necessary in the process of reconstruction, traces were constantly coming to light of good things that had been obliterated and forgotten or else built over and hidden from sight.

The original house, incorporated in a part of the present servants' wing, was built about 1708. Just what its aspect may have been, we can now only conjecture. It was a small, staunchly built stone structure, and in all likelihood was much the same as any other little Pennsylvania stone farmhouse of the period. All its pristine character disappeared at the time of the first remodeling and addition, about 1810, when the exterior, it seems, was first coated with stucco, and when the mantelpieces, doors, shutters and all other interior and exterior woodwork were changed to conform with the prevailing mode of the time. The manner of the time, of course, was the Regency or Græco-Roman manner of the early nineteenth century, of which Latrobe, Robert Mills, Strickland and the rest of the coterie who followed in Latrobe's wake were the apostles,—a manner of neo-Classic interpretation that had begun in England somewhat earlier with Henry Holland, was carried on by Nash, Papworth, Cockerell, Mylne, Foulston and others, and reached its full maturity during the regency and

"Kenwood," Bethayres, Pa.
The appearance of the building before the recent remodeling



SOUTH FRONT AND SERVICE WING

EAST FRONT AND SERVICE WING
"KENWOOD," BETHAYRES, PA.
LEIGH FRENCH, JR., ARCHITECT; HAROLD D. EBERLEIN, ASSOCIATED

NORTH AND WEST FRONTS FROM DRIVEWAY

WEST FRONT

"KENWOOD," BETHAYRES, PA.

LEIGH FRENCH, JR., ARCHITECT; HAROLD D. EBERLEIN, ASSOCIATED

"GAZEBO," TERRACE AND FISH POOL
"KENWOOD," BETHAYRES, PA.
LEIGH FRENCH, JR., ARCHITECT; HAROLD D. EBERLEIN, ASSOCIATED

NORTH DOORWAY
"KENWOOD," BETHAYRES, PA.
LEIGH FRENCH, JR., ARCHITECT; HAROLD D. EBERLEIN, ASSOCIATED

Dining Room

reign of George IV,—and hence the name.

The dining room at Kenwood, occupying most of the area of the present dining room, was built at the time of the first remodeling. The next addition took in the library, with its semi-hexagon end, and the space between the library and dining room now taken up by the stair hall. The final addition completed the outward structure of the main body of the house as it stands today. At this time the verandas were built and equipped with cast iron fretwork supports. The oldest part of the house and the dining room addition of the early nineteenth century were all on the same level. The second and third additions had a ground floor level 3 feet higher. These levels have been retained. Upstairs, the floor levels after the third enlargement did all sorts of strange things, and to go from one part of the house to another was like following the course of a roller coaster. All changes subsequent to the third enlargement were interior alterations of little consequence so far as the structure was concerned.

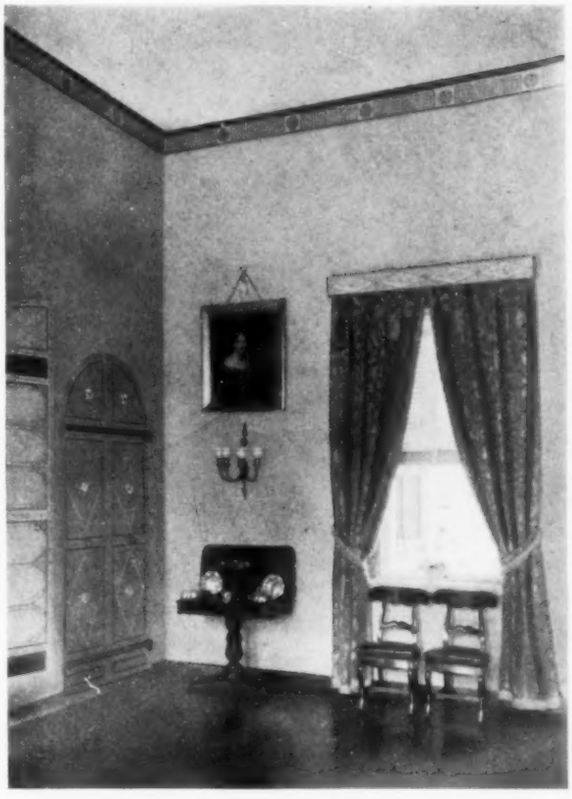
Several of the accompanying illustrations give some idea of the outside of the house as it appeared after it had been unoccupied for 20 years and just before the recent remodeling was undertaken. At this stage, inside there was a splendidly proportioned drawing room, 36 feet long by 17 feet wide, with a ceiling slightly more than 13

Service Wing
"Kenwood," Bethayres, Pa.
Leigh French, Jr., Architect; Harold D. Eberlein, Associated

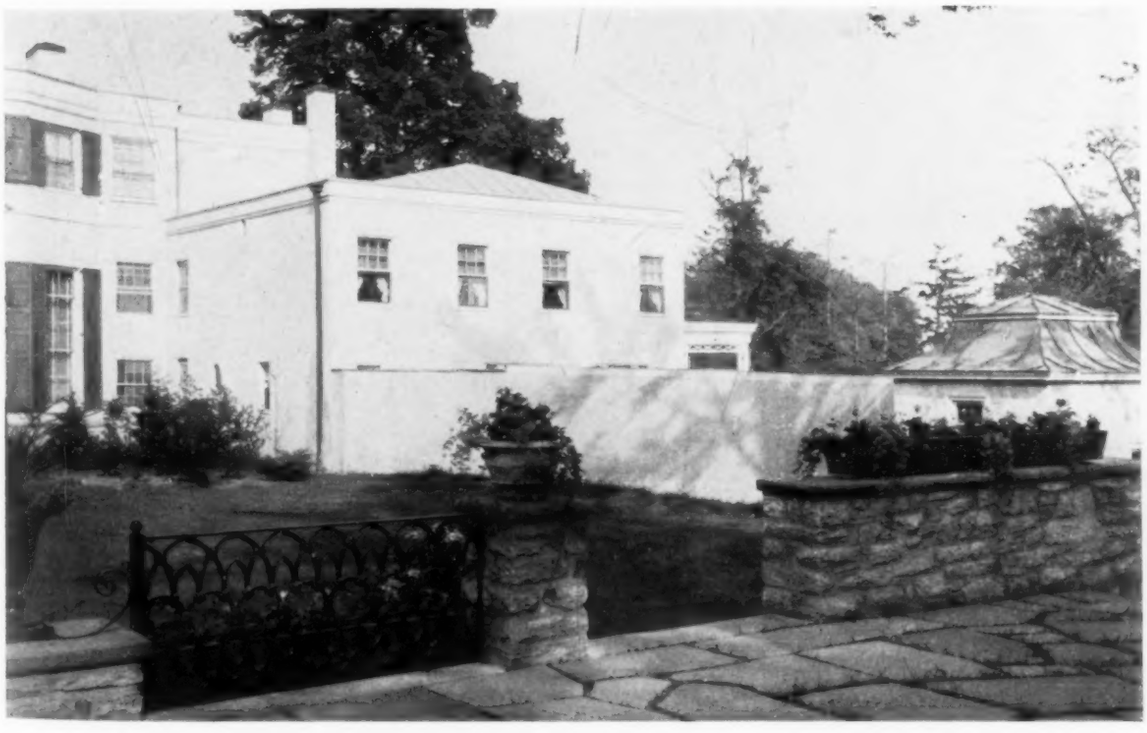
feet high; there were five full length windows, nearly 11 feet high, with triple-hung sash, three on the long east side, and one each at the north and south ends. There was also a long hall, 36 feet long and 12 feet wide, running through the house from the north door to the south door. In both the drawing room and the long hall the plaster decorations were of excellent character and in good condition. The library, to the west of the long hall, was 27 feet long to the extremity of the half-hexagon bay, and in width a little more than the width of the bay.

The exterior changes were more radical in appearance than in actual fact. The eaves were sheared off, and a parapet was substituted in such a manner that the low part of the gutter is only a few inches below the coping, so that there is no difficulty with snow lodging in a deep pocket; the veranda was removed from the east side, and a flag-paved terrace was built in its stead, corresponding with the flag-paved terrace added on the west side, which never had a veranda; and the north and south verandas were slightly narrowed and re-roofed with tin with standing seams.

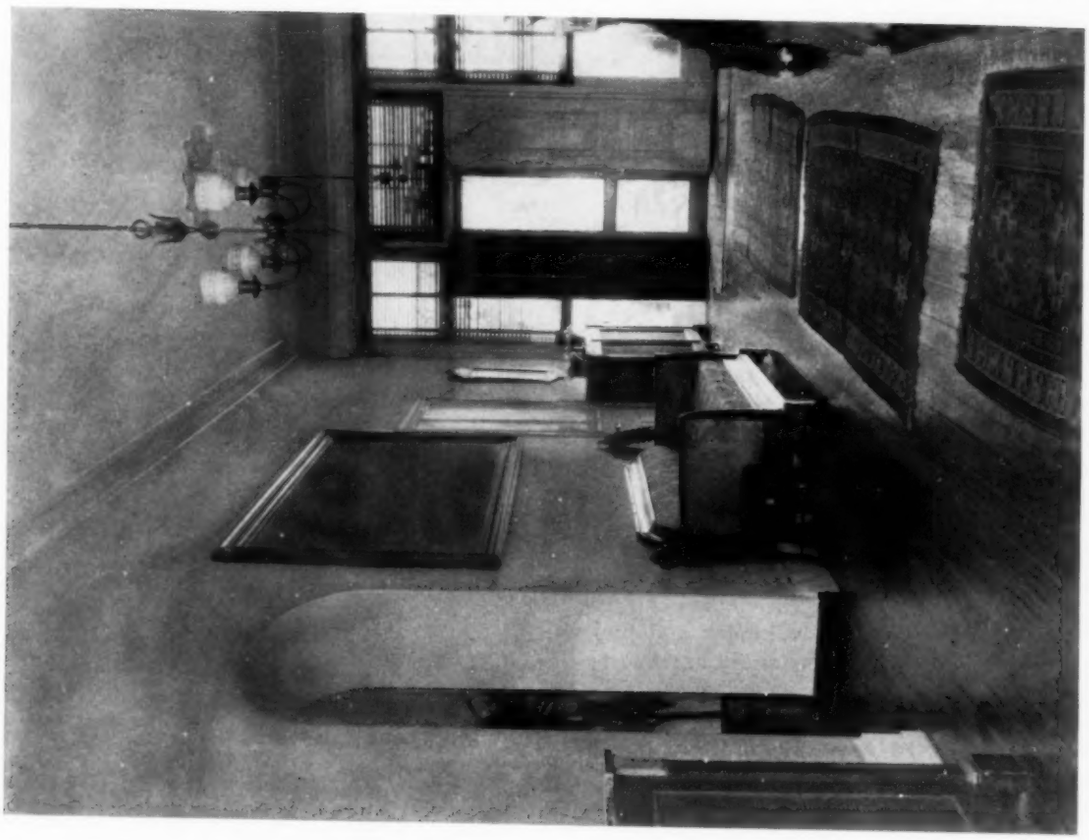
Inside the house, the stair hall is paved with black slate, and the stairs,—of one continuous run, which ascends in an elongated oval,—are also of black slate, polished. The balustrade is of wrought iron with a polished brass handrail,



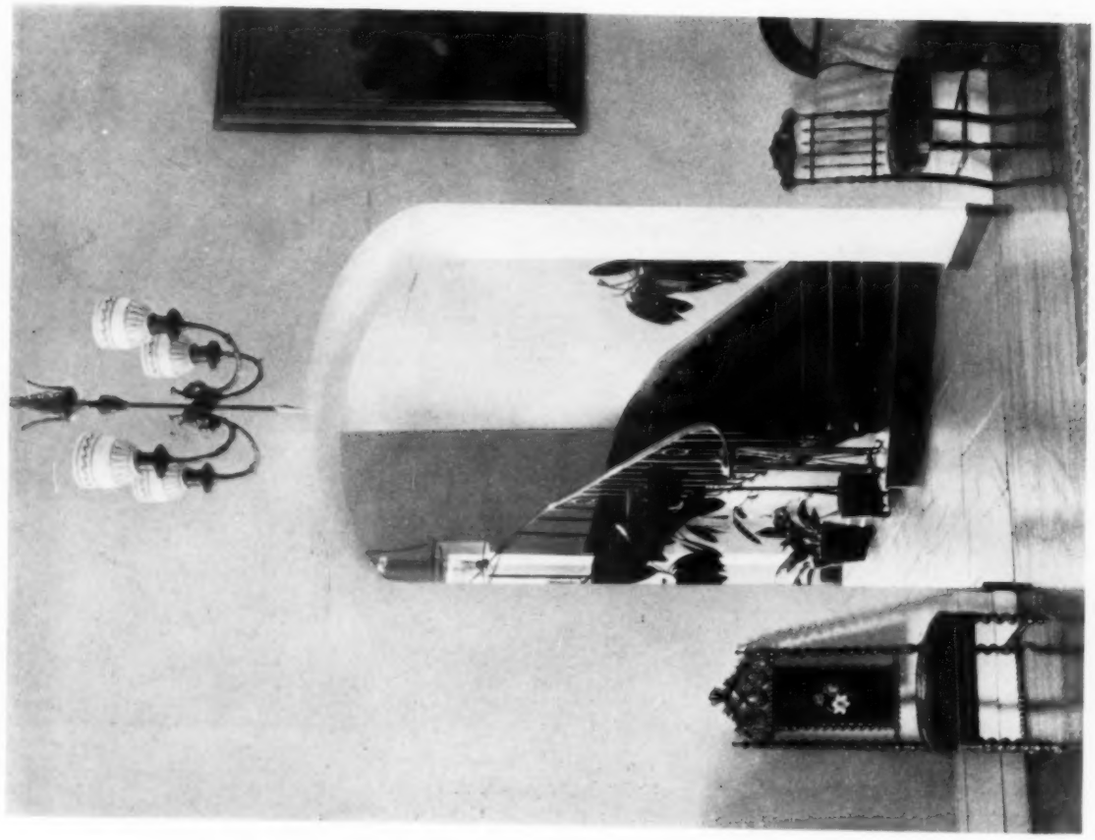
One End of Dining Room



New Part of Service Wing
"Kenwood," Bethayres, Pa.
Leigh French, Jr., Architect; Harold D. Eberlein, Associated



MAIN HALL



STAIR HALL

"KENWOOD," BETHAYRES, PA.
LEIGH FRENCH, JR., ARCHITECT; HAROLD D. EBERLEIN, ASSOCIATED

DRAWING ROOM FIREPLACE

DINING ROOM FIREPLACE

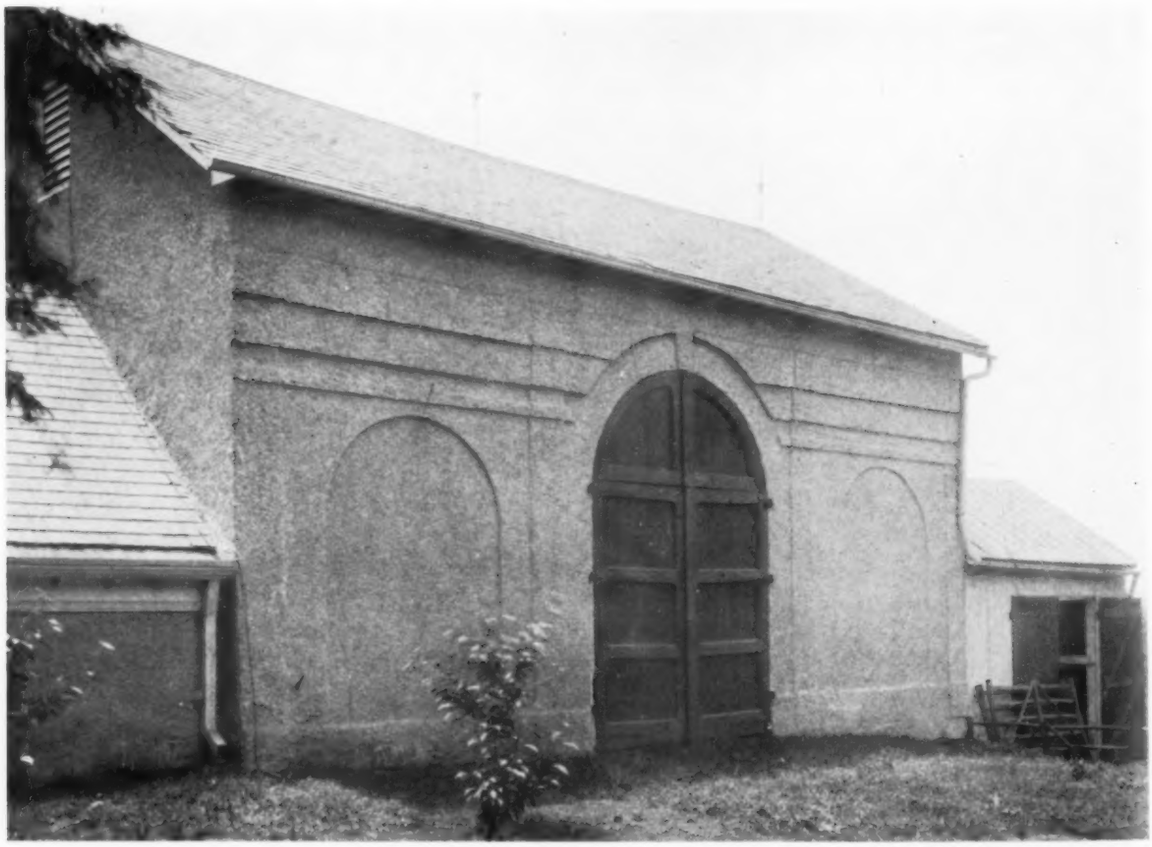
"KENWOOD," BETHAYRES, PA.

LEIGH FRENCH, JR., ARCHITECT; HAROLD D. EBERLEIN, ASSOCIATED

and the newel post has a polished brass cap surmounted by a crystal ball. In the stair hall the landing of the upper floor is likewise paved with black slate. The base is of black slate, and the walls are painted a cool sea-green, the window reveals and the jambs and soffits of the arches being white; the ceiling is white, and the cornice is gilded with black fillets.

The dining room, 3 feet lower than the stair hall, is paved with black terrazzo, and there is a 4-inch base of black marble lined with gold. The walls are painted apricot color, and the woodwork is a rather light peacock green-blue lined with jade green, a lighter tone of the same peacock green-blue being used for the ceiling, which is studded with small gold stars. The cornice is composed of rope, first saturated with black paint and then put in place; the frieze consists of Greek key-frets and roundels painted in gold. There is no wood trim around the central doorway or the arches of the two flanking china cupboards; the heavy unpaneled doors are hung flush with the plaster surface of the wall, and the straps of the stout iron hinges are incorporated in the scheme of the painted decoration of the doors. These decorations are in light jade green, white, gold, black and old rose on the peacock green-blue of the groundwork. The same scheme is continued in the painted cornices from which the curtains hang, and the curtains themselves are of old Italian rose damask brocaded in silver, with green-blue fringes. The Venetian blinds are white.

In the library the walls are painted a light yellow, with all the woodwork a deeper tone of yellow lined with gold, and the Venetian blinds are the yellow of the walls. The curtains are of scarlet damask brocaded with a small gold pattern and fringed with apple-green matching the apple-green ground of the cornices, which are lozenge-hatched with black lines, with gold quatrefoils at the intersections. In the drawing room the woodwork is painted a dark gray-blue; the walls are of Chinese pink, affording an appropriate background for early nineteenth century portraits, and the curtains are of brilliant yellow damask hanging from black cornices with classic gold ornament in relief. Here, as elsewhere, the cornices are of simple carpenter's make painted, with the compo ornaments applied and gilded. The mantel is likewise an unpretentious piece of millwork,



North Front of Barn, Unaltered
"Kenwood," Bethayres, Pa.

BOOK DEPARTMENT

CONCRETE, PLAIN AND REINFORCED

A REVIEW BY

CLIFFORD WAYNE SPENCER

THE sole limitation to structural extent in architecture has always been the strength of the materials used in construction, although legend implies that the Tower of Babel would surely have reached the heavens had it not been for the confusion of tongues. We of the present day, however much we may marvel at the skill of the ancient builders and the sizes and staunchness of their structures, know that the materials with which they had to work imposed a very definite limitation on the height to which their structures could be carried. Man in his building has always striven for greater height, and in the effort to attain it he has gradually worked out new methods of disposing the materials at hand in such a way that their strength be utilized to the greatest possible advantage. The Romans by developing the arch accomplished much in this direction, but even with use of this clever device the utmost limit to which stone and wood could arise was attained in the Gothic cathedrals of the middle ages, and it was not until the latter part of the nineteenth century that any further progress in this direction was made,—the beginning of what we call "steel construction."

During the period just preceding the invention of the skyscraper, the tendency of people, especially in America, to congregate in limited areas gave a fresh impetus to the attempts to build larger and taller structures. In these attempts it was found that the old materials were quite inadequate. If a structure of more than ten stories were built of masonry, it was found necessary to make the lower walls so massive as to cause them to occupy nearly the whole floor area, and though several such structures were actually built, it soon became evident that they were quite unsatisfactory from an economic point of view. It was at this point that the introduction of the new materials,—structural steel and concrete,—made possible the development of the skyscraper as we know it today. As our modern materials are superior to those of the ancients in strength and utility, so is our

"*Hotel Planning and Outfitting*"

EDITED BY

C. STANLEY TAYLOR and VINCENT R. BLISS

Here is a volume which for the first time adequately reviews the entire subject of the modern hotel,—its planning, designing, equipping, decorating and furnishing. It covers every detail, from the beginning of sketch plans to the registration of guests when the house has been completed and opened. All the different types of hotels are dealt with,—the Modern Commercial Hotel, the Residential or Apartment Hotel, the Resort Hotel, and the Bachelor Hotel. The volume is replete with views of hotels in different parts of the country; their exteriors and interiors, and in many instances their plans are included and fully analyzed.

The editors have been assisted in the preparation of the work by widely known hotel architects and interior decorators and by actual operators of hotels,—practical men, experienced in the management of the "back" as well as the "front" of a hotel. The volume's treatment of hotel furnishing and equipping constitutes the final word on this important subject. There are included views of hotel restaurants, cafeterias, kitchens, pantries, "serving pantries," refrigerating plants and all the departments which are necessary in a modern hotel of any type. The work is of inestimable value to architects and engineers, as well as to practical hotel men.

438 pages, 8½ x 11¼ inches—Price $10

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"International Airports"

By STEDMAN S. HANKS

Lieutenant-Colonel Air Corps Reserve

THE rapid development of commercial aëronautics is presenting to American architects what bids fair to becoming an excellent opportunity for using skill in designing, constructing and equipping airports. The subject has hitherto received but little attention in the architectural press, and but few works on the subject have been published.

In this volume a highly trained and experienced aëronaut reviews the subject. He considers the problems of American airport development from a study of what has been done abroad against the background of the author's intimate knowledge of airport conditions here. In its preparation, Colonel Hanks made a prolonged tour of European airports for the purpose of learning in what ways their experience can serve as a guide for airport construction in the United States.

In making his study he received the assistance of many leaders in European aëronautics and enjoyed exceptional facilities for thorough investigation. Much information on the details of foreign airport operation is accordingly given that has never before been available in published form. The design, construction, and management of the outstanding airports is described and compared with that of the airports in America. Up to the present time, Europe has led the world in air passenger traffic. Colonel Hanks discusses passenger facilities at airports, tickets, baggage regulations, transportation of passengers to and from airports, and other details of European passenger practice. He considers also the problem of developing the transportation of freight by air and tells what has been done in Germany in the inauguration of combination air and rail service for express shipments.

The opportunities for substantial additional revenue to the airport from supplying recreational facilities and other adjuncts of the modern resort; an outline of an ideal airport combining the best features of successful American and European practice; a typical airport profit and loss statement; airport regulations; are other valuable features of this book.

195 pp., 5¾ x 8½ ins. Price $5.

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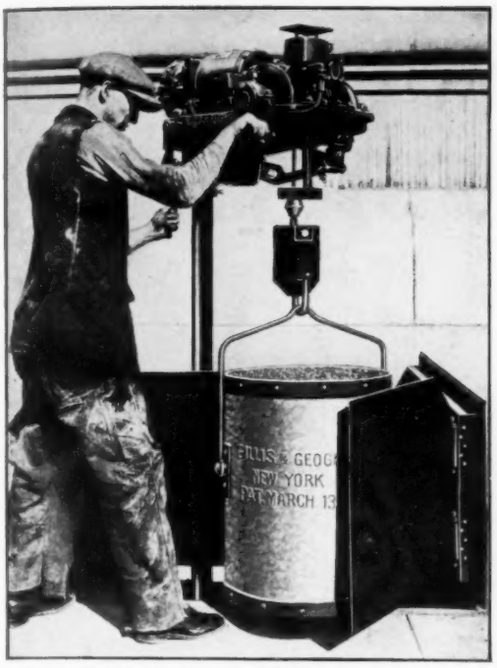
knowledge of the principles underlying their use superior to the science available to the ancient builders, and as our structures become larger and more and more complicated, a greater degree of scientific knowledge is necessary for their safe construction. In the designing of steel framework, modern engineers have attained an amazing proficiency which has been manifested in great buildings and bridges everywhere.

Although it is of course purely a matter of opinion, there is every reason to suppose that the outstanding building material of the future will be ferro-concrete, and one has but to study some of the great modern churches and public structures which have been built of this material to realize how great is the potentiality for beauty and strength latent therein. The possibility of spanning enormous spaces with great parabolic arches in reinforced concrete is being utilized extensively, especially in Europe, and it is difficult to predict to what undreamed of proportions the buildings of the future may attain. At all events, it is quite safe to say that the successful architect of the future will be the man who knows his concrete. As the use of concrete has developed, there has grown up a considerable volume of published material on the subject, there being many excellent works dealing with all phases of the science of building in concrete. One of the recognized standard works in this field is "Concrete, Plain and Reinforced," written by Frederick W. Taylor and Sanford E. Thompson, but as is the case with all new and rapidly developing sciences, new theories and facts are constantly being discovered and applied, and the work has recently been brought up-to-date and rewritten by these authors and by Edward Smulski. The new edition, which is the fourth, is in four volumes, the second volume being the subject of this review. Volume I, already issued, deals with concrete and reinforced concrete structures from the standpoint of design, while Volume II goes still more deeply into the technical and practical aspects of the subject and covers the theory and design of continuous beams, frames, building frames and arches. Taken altogether, the two volumes comprise one of the best and most comprehensive treatises ever published on the subject. Data on continuous beams as specified in the findings of joint committees and in various building codes are given for ideal conditions where the spans of the beams are equal and the loading uniformly distributed. In all other cases, understanding of the action of continuous beams and of the principles upon which formulæ can be based is essential for the intelligent designing of concrete structures. In the chapter on continuous beams, formulæ and explanations governing a large variety of possible cases are given, and the findings are carefully tabulated. Maximum shears and bending moments for continuous beams up to four spans, with or without fixed ends, are given, and the influence of cantilevers on continuous beams is investigated. Also moments of inertia and their effect on continuous beams will supply much data of practical value to bridge engineers and others interested in the designing of beams with straight or parabolic haunches.

The practical application of the formulæ and principle presented is demonstrated by five actual problems worked out for various arrangements of continuous beams. This chapter may be considered the most complete treatment in any language of continuous beams



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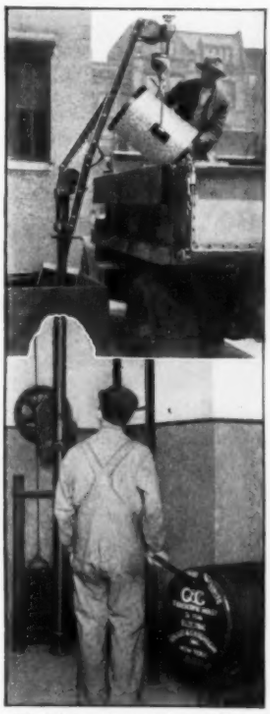

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College Architecture in America

Its Part in the Development of the Campus

By

CHARLES Z. KLAUDER *and* HERBERT C. WISE

Music Building, Smith College
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A NEW and ever higher standard is being established for the architecture of educational structures of all kinds. Some of the most beautiful buildings in all America are those venerable halls in academic groves in Charlottesville, Cambridge, Princeton and elsewhere built by early American architects, and now after long decades of indifferent designing and careless planning American architects are rising anew to the situation and are designing educational buildings of every type which closely rival even the best work of a century ago, while in planning and equipment they establish a standard which is wholly new.

¶ In this valuable and important work two widely known architects of educational buildings collaborate in reviewing the entire situation as it applies to college and collegiate architecture. They have carefully studied practically every important institution in the country, and in their text they discuss administration buildings; dormitories; recitation halls; chapels and auditoriums; gymnasiums; libraries; and structures intended for certain definite and specific purposes, such as the teaching of music, all this being well illustrated with views of existing buildings and in many instances with floor plans and other drawings. A valuable and extremely practical work to add to the equipment of any architect's office.

301 pp., 7½ x 10 ins.
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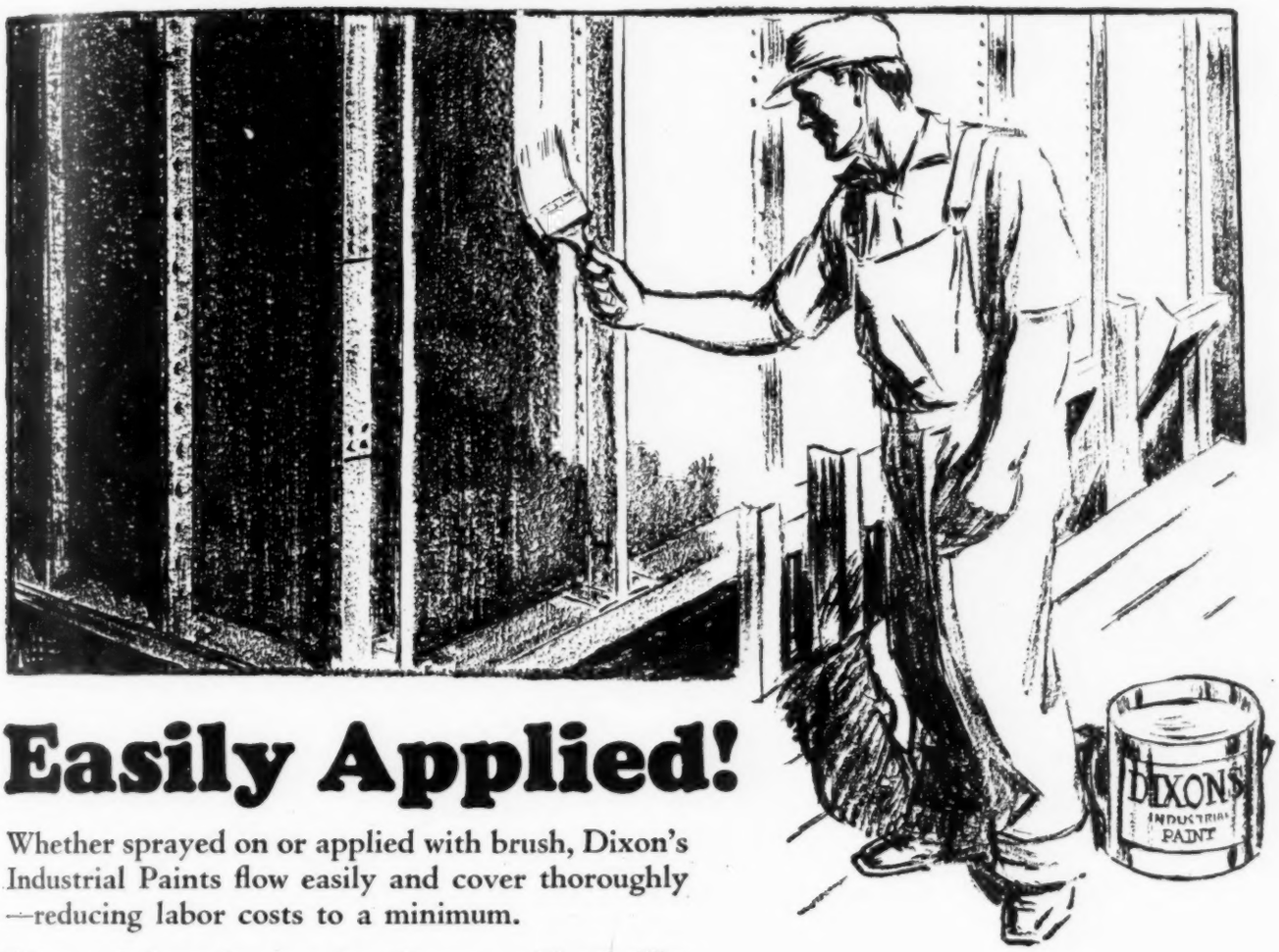
NEW YORK

with uniform moment of inertia, which are freely supported at intermediate points and either freely supported or fixed at the two end supports. The care of unequal spans for such beams is handled in usable form. The formulæ here given may be applied to the designing of concrete slabs, joists or beams upon a steel framework. They may not be properly applied to rectangular slabs, joists or beams built monolithically with concrete columns and girders as their intermediate supports, which is by far the more common practice in modern construction. The solutions also do not apply to T-beams where the moment of inertia at the center is often twice that at the support, but within the limited range in which they do apply, the solutions are exceptionally complete and usable. The treatment of the effect of varying moments of inertia starts with cases in which the I at the center of span is one fiftieth of that at the support and stops when they are equal. In actual building it is far more common that the I at the center of the span exceeds that at the support, since T-beams and T-joists are the usual flexural members employed in design.

The authors seem to have had the rectangular beam and the one-way slab, with or without brackets, chiefly in mind in this whole treatment. The method of computing the moment of inertia of a reinforced concrete member of flexure, as given, is satisfactory for preliminary design, but the final design should be more carefully worked out. The analysis of bending and direct compression is exceptionally complete for rectangular sections, though here, as in other parts of the work, departures from standard notation result in unnecessary confusion and delay to the reader. Many diagrams are saved by giving only those for N-15 and by supplying two simple conversion tables for other values of N. Circular sections are not discussed. Detailed solutions of many cases in the treatment of rigid frames are given and present much data that have heretofore been available chiefly in European texts. These are limited largely to structures of one or two panels in width, leaving the more common multi-bay building to be worked out by the general slope-deflection equations which are given. This portion of the book is very usable in both concrete and steel design, but it is a matter of regret that the great possibilities for a condensed treatment, more applicable to rapid design, have not been utilized. Four chapters are devoted to the treatment of rigid arches with simple, effective analysis and clear exposition of the basic structural action. Both approximate and exact methods are given.

The authors have planned the text so as to make it useful to the greatest possible number of persons, including students and professionals. For the student the theory and derivation of formulæ are given, while final formulæ are furnished for practical use. To take care of unusual cases, general formulæ are given, the more common cases being covered by simple final formulæ supplemented in many cases by constants and diagrams, the use of the formulæ being made clear in all cases by giving practical examples as illustrations.

Although the volume is a new edition of an already well known work, the material contained in the second volume is entirely new and is not contained in any of the previous issues. The authors believe that, "this is the first book in any language in which the subject of statically indeterminate structures has been fully treated



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from both theoretical and practical standpoints." In all cases easily understood explanations are furnished for the action of statically indeterminate structures. The relation between statically indeterminate and simple structures is given, and the causes for the difference in action are explained. Bending moment diagrams for rigid frames show in all cases the type of bending moments to which the various frames are subjected for different types of loading. When used intelligently, these alone may form a basis for approximate solutions of problems in cases where accuracy is not of prime importance. The chapter on building frames contains material and formulæ never before published. The treatment of arches is of great importance, and the explanations, formulæ and diagrams presented on this branch of the subject are original and of great value in understanding the action of an arch when subjected to loading or to changes of temperature. Of especial interest at the present time, in view of the great popularity of the parabolic arch as the basis of the design of large modern buildings, are the formulæ for this type of arch. The bending moments and thrusts at the critical sections for these arches may be taken directly from tables given.

From the point of view of the general architect, this book may seem rather involved and unnecessarily technical, when such problems can usually be referred to the structural engineer for solution. However, with architecture tending more and more toward the solving of its problems in accordance with simple engineering principles, a working knowledge of the underlying principles is very much to be desired, and to those who have to make the preliminary designs of structures involving concrete construction, the methods here described and the tables here presented for arriving at rapid approximations will be very valuable. Certainly if one wishes to have available information on the mechanics of concrete design it would be hard to find a more complete or standard work than is published in these four volumes.

CONCRETE, PLAIN AND REINFORCED. Volume II. Fourth Edition. By Frederick W. Taylor, Sanford E. Thompson and Edward Smulski. 688 pp. 6 x 9 ins. Price $7.50 Net. John Wiley & Sons, Inc., 440 Fourth Avenue, New York.

MEDITERRANEAN DOMESTIC ARCHITECTURE IN THE UNITED STATES

A REVIEW BY

WILLIAM P. SPRATLING

USING the phrase, "Mediterranean Domestic Architecture," Rexford Newcomb has gathered under that colorful title a more than interesting collection of illustrations showing distinguished present-day adaptations of Latin-Moorish architecture in America. Architects of almost any part of the country, though particularly those practicing in climates where such things are practical, will find this material sound, well selected and probably extremely valuable. Mr. Newcomb has already brilliantly distinguished himself in the profession as one of those few who are willing and able to take upon themselves the selective-critical duties of the true architectural educator. Of minds such as his there are all too few in the profession. His has been a work not only of explanation, but of true interpretation,—and stimulation. In the brief text he has tied his theme in well with tradition without being tiresomely specific historically. But at times one suspects Mr. Newcomb of painting an almost too alluring picture of his medium; or is it merely his literary phraseology? At that, he has said many things which will doubtless open the eyes of some of the more conservative members of the profession to certain possibilities of color and the like. He casually explains a certain electicism in the use of these "Mediterranean" styles by the variety of our climatic conditions in America, though neglecting to add that a comparatively unsophisticated America is likely to indulge in what may be termed nothing less than "stage stuff."

For one who likes to see the "stylistic sources" of these things inquired into more searchingly, Mr. Newcomb's remarks about derivations from what he calls the "Mexican Colonial" are perhaps inadequate. Speaking of Santa Fe and Mexico, he remarks: "This many-terraced type, fine examples of which are still to be seen in Taos, Laguna, San Ildefonso and other places, generally passes under the name 'pueblo,'—pueblo of course referring to a peopled place, or village, the generic Spanish term in Latin America"; and: "When the Spaniards employed these Indians to build structures with European plans and utilities, of the materials and upon the lines of the native work, there resulted a new type, half-Spanish, half-Indian, the like of which has nowhere else been developed." In this, of course, Mr. Newcomb is either entirely ignoring or merely neglecting to mention the vast accumulation of Spanish Colonial things in Mexico, where there are more than 15,000 early domed structures, most of which have received the definite impress of the hand of the native Mexican,—the Indian. However, he makes some acknowledgment in closing, saying that, " . . . by relying upon the early local expression in each community, and by the judicious selection of forms from the varied parent styles of Spain, Mexico, Italy or north Africa, the architect of our time may find a grammar sufficiently broad. . . ."

Mr. Newcomb's examples are well selected and run the whole gamut as to types. There are a few which are pretentious and frankly expensive; some of the simple utilitarian and intensely domestic types, and there are many, are not only very beautiful but also very distinguished. None of them are commonplace, and all show that ingenuity of design which gives evidence of the real fertility of imagination among the architects of America. And all of these examples, being related to the conditions out of which they have sprung, are certainly integral with the life of America today. The material for this book has not only been well selected, but fully illustrated. For each of the 70 examples shown there are probably an average number of six to eight illustrations from well taken photographs, and beautifully and consistently well drawn plot plans. As an example of bookmaking, Mr. Jansen has made a splendid thing of it. It is a volume which will make a distinguished addition to the shelves of an architect's library.

MEDITERRANEAN DOMESTIC ARCHITECTURE IN THE UNITED STATES, 223 pp. 10½ x 15½ ins. Price $15. J. H. Jansen, 315 Caxton Building, Cleveland.

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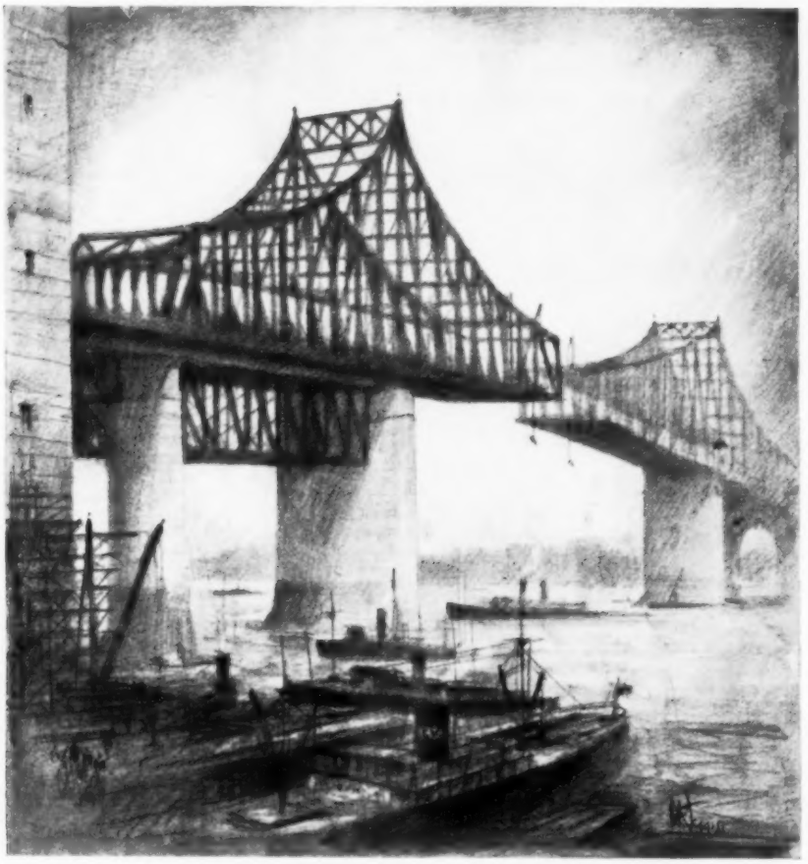

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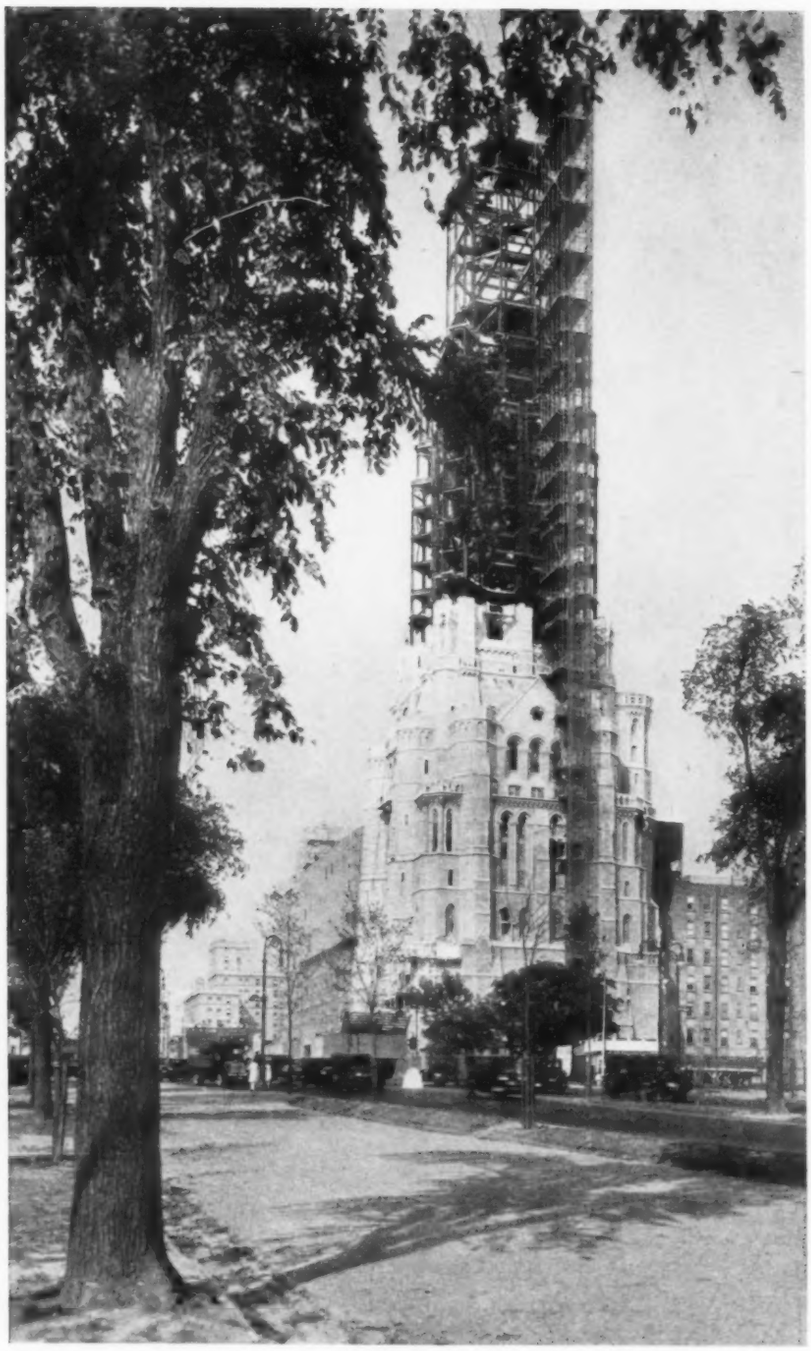

STONE, STEEL AND SCAFFOLD

RIVERSIDE CHURCH, NEW YORK

HENRY C. PELTON AND ALLEN & COLLENS, ASSOCIATED, ARCHITECTS

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The Architectural Forum

UNIV OF MICH

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COLD STORAGE WAREHOUSES

BY

CARL de MOLL

ARCHITECT AND ENGINEER, THE BALLINGER COMPANY

THE preservation of food has always been an important factor in the comfort, health, and existence of the race. In early times food was preserved either by burying it in the earth or by drying it in the sun. One of the steps in the progress of food preservation was the recognition of the fact that a low temperature would retard the progress of decay. A cellar or cave maintained a relatively low temperature throughout the year, being somewhat warmer than the outdoors in winter and much cooler in summer. Of course the smoking of meats was an early way of preserving them, and spices played an important part in food preservation. The search for short routes by water to the spice-producing countries of the East brought about many of the discoveries of the New World. Pickling is also one of the early forms of preservation, and alcohol still has its uses in this connection. All of the preservatives, however, change the nature or at least the taste of foods, and it remained for artificially produced conditions of cold and controlled relative humidity to keep foods for long periods without appreciable change from their fresh condition. The last 40 years have brought a tremendous development in the science of refrigeration and the storage of foodstuffs and other perishables.

Chemists and physicists had known for many years that it was possible to extract heat from almost any substance, but it was not until the latter part of the nineteenth century that machines were devised to do this on a relatively large scale. Fundamentally, a refrigerating machine is merely an appliance to extract heat from one place and put it into another. Any refrigerating machine must be equipped with water, air or some other substance to take the heat extracted by the machine away from the material or space to be cooled. Refrigerating machines were in early days used in breweries, and later in slaughter houses and meat packing houses. Probably their most rapid development began with the erection of great numbers of cold storage warehouses all over the country. With the increased use of cold storage warehouses there came the realization of the extreme importance of securing relative humidity as well as accurate temperature control. As the designing of a modern cold storage warehouse for the preservation of food products is a very complex problem, it is imperative that the best specialized engineering service be obtained. Only by the employment of experienced experts is it possible to obtain the best and most efficient building for the least expenditure of money.

In general, cold storage warehouses can be roughly divided into two general classes,—one, buildings designed for the preservation of a particular substance at one temperature; the other, buildings which must be capable of taking care of a large variety of substances, each at a different temperature. In the first class are buildings for the storage of citrus fruits, apples, or meats. It is important, in the storage of fruit, to recognize the fact that the general tendency of a cold storage warehouse is to reduce the relative humidity of the air. This is deleterious to the product, as it extracts a large amount of water from the fruit, thus drying it and reducing its size and quality. It is, therefore, imperative that a properly high relative humidity be maintained at all times. This is complicated by the great danger of there being fungus growths and mould, which will always appear if the humidity is too high. This has led to the adoption of elaborate systems of ventilation, and it has also led to the introduction of use of chlorine fumes for the prevention of mould.

Where a building is for the general storage of a great variety of foods, it is necessary to divide it into a number of separate rooms. There are many foods, including meat and fish, that it is frequently desirable to receive and place in rooms with a temperature at or below zero, known as

Quaker City Cold Storage Warehouse, Philadelphia
The Ballinger Company, Architects and Engineers

"sharp freezing rooms," where the material is frozen, then transferred to a room slightly below the freezing point where it can be carried in a frozen condition almost indefinitely. This of course leads to serious complications in insulation, as goods piled close to the wall next to a sharp freezing room are likely to freeze unless there is proper air circulation in the room. A room over a freezing room must have the material stored on high dunnage and air circulation maintained across the floor. The building must, of course, be designed with the various coils under separate control, so that the temperature of the room may be changed to suit the various seasonable commodities as they are stored at various times during the year. Over a period of years, through scientific research, there have been established ideal temperatures and relative humidities for practically all the food products which are usually carried in cold storage warehouses.

Important factors in the design of a warehouse are the arrangements for receiving, distribution, checking and delivery of goods. Most warehouses of any size are, of course, equipped with railroad sidings, most of the goods coming in by railroad in carload quantities, and after the period of storage distributed to trucks or wagons from an adequate shipping platform. This necessitates very careful checking, so that not only the packages belonging to various owners, but various brands can be so segregated that they can be taken out of storage as the demand warrants. It is found that certain manufacturers are packing the same or similar goods with a number of different brands or labels. These must, of course, be segregated, so that they are obtainable with a minimum amount of handling. There are some houses where the goods are received by trucks or wagons, and after a period of storage, are shipped by railroad. This is more often true in houses built for a single commodity, which is received from the growers at the ripening time and carried in storage and shipped by carloads as the demand warrants. The design of the mechanical equip-

Interior of Quaker City Cold Storage Warehouse Showing Construction
The Ballinger Company, Architects and Engineers

ment of a storage house is very important, due to the large expenditure of power which is involved. Slight losses become extremely serious in additional cost. The availability of a large supply of water is imperative, and if it is possible to obtain this water from deep wells, giving a low temperature water at all times in the year, great economy can be obtained. It is also usually advisable to use outside current wherever possible, as, there being no use for the heat, the public service current is usually cheaper than that of an individual power plant. Many cold storage houses have, as an auxiliary business, the manufacture of ice, in some cases installing large rooms for ice storage, so that a relatively small plant working every day in the year can store ice during the colder weather to be available at the time of greatest demand. The owner can thus supply a very large demand at certain seasons with a relatively small expenditure for ice-making equipment.

The building should be of fireproof construction, with adequate insulation, the best material being compressed cork slabs, 4, 6 or 8 inches in thickness. In general, there are two systems of insulation; one known as the "envelope" system, in which the entire storage area is enclosed in a continuous envelope of cork,—that is, a multiple-story building of 10 or 12 floors would have the first floor used for receiving and shipping; the second floor would have a thick cork insulation. The roof and four walls would also be insulated. The intervening floors would simply be of concrete

Great Lakes Terminal Warehouse, Toledo
William H. Adams, Architect

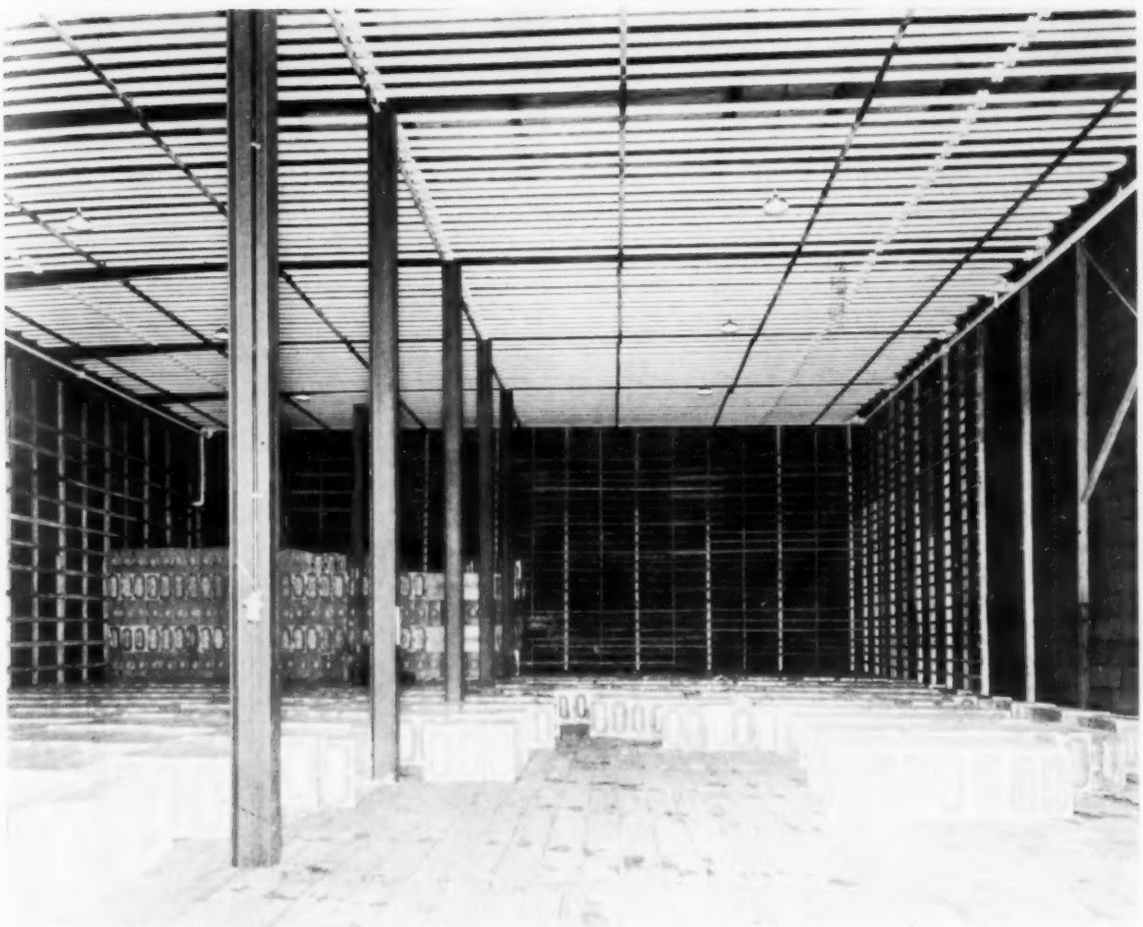
or steel construction. This system is usually recommended only for a large building and for storing one kind of goods, where the same temperature is carried through the entire house, since it would be impossible to carry different temperatures on the various floors without insulation between. It also has the disadvantage of being extremely difficult to avoid there being settlement cracks in the insulation, especially in the upper part. In some buildings which have been built under this system, it is necessary to have periodical inspections made of the insulation, carefully calking any cracks which develop. Where rooms of different temperatures are needed in the building, it is much more advantageous to segregate each of

Interior of Great Lakes Terminal Warehouse, Toledo, Showing Construction and Equipment
William H. Adams, Architect

Effective Design of the Bekins Van & Storage Co., San Francisco
F. Eugene Barton, Architect

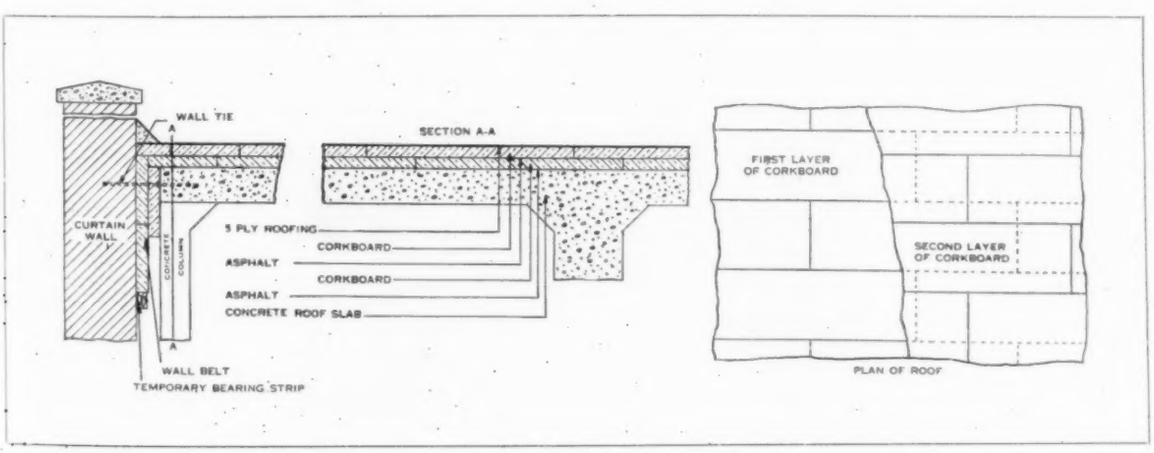
these rooms with heavy insulation, sometimes placing insulation on every floor. The building for the Quaker City Cold Storage Company in Philadelphia, illustrated here, is designed to contain rooms of all temperatures from below freezing to rooms held slightly above freezing, for the storage of vegetables, candy, etc. The apple storage warehouse for the Arrington Cold Storage Company at Arrington, Va., is designed for the storage of apples in barrels, solely. An interesting feature of this building is that only the alternate floors are solid. The intervening floors are of slat construction, so that the bunker containing the refrigerating pipes and ventilating system is available for two stories of storage.

The question of insurance is important, due to the fact that this cost must be added to the storage charges, so that any saving is directly reflected in profits. It is, therefore, imperative that every effort be made in the design of the building to obtain the minimum rate both on building and contents. There should be the proper division of areas by fire walls, segregation with fire doors, automatic sprinklers, fire hydrants and hose reels through the building, adequate water supply and pumping equipment. The sprinkler equipment will necessarily be of the dry pipe type, and special precautions should be exercised so that there shall be no condensation to freeze in the pipes or around the heads. The electric lighting equipment must be entirely open wiring, as it has been shown that an installation of conduits is impracticable, due to accumulation of moisture in the pipes. The elevators should be of a large size, and of high speed, with an automatic leveling system. The size of elevators should be adapted to the size and number of trucks which it is decided to use, selecting a standard truck which will hold the largest amount it is possible for one man to handle. It is also desirable to consider the use of platforms for lift trucks. In a tall building, the elevator should run at as high a speed as it is possible to obtain. As there is a great deal of leakage of cold air down the elevator shafts when the doors are open, most houses are equipped with vestibules on each floor. It is much better, however, to in-

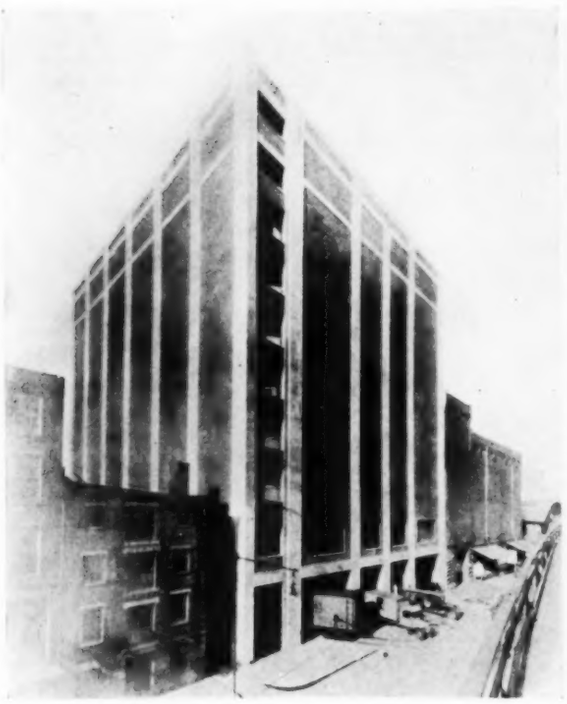


Interior of Ice Storage Plant of Borin Brothers, Detroit, Showing Insulation and Temperature Maintaining System

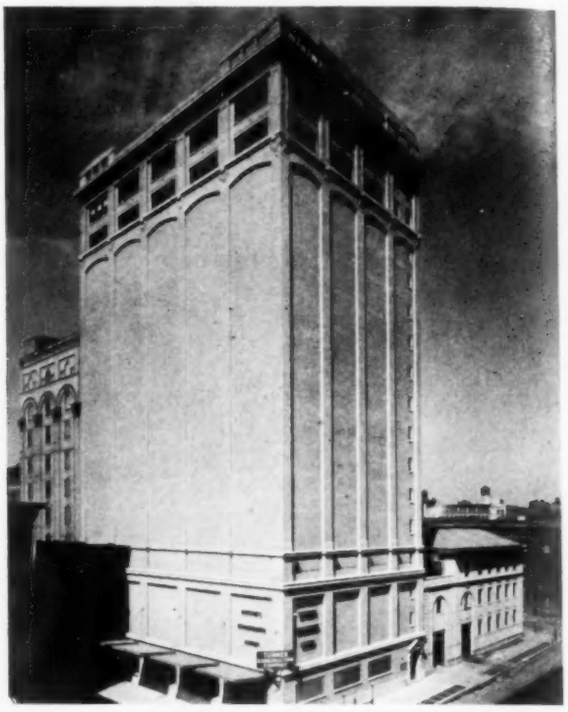
sulate the floor, roof and three sides of the elevator car with heavy cork, installing a rubbing strip around the door and installing weather strips of heavy soft rubber bearing on these rubbing strips, so that when the elevator car is level with the floor, the door can be opened and no air can escape down the shaft around the door opening. It is also desirable to use heavy insulation around the door frame to avoid condensation at the sill, there being a great deal of trouble due to condensation forming around the sill and freezing where rooms are closed for a long period of time.



Section and Plan Showing Method of Insulating a Cold Storage Building



Quaker City Cold Storage Co., Philadelphia
The Ballinger Company, Architects and Engineers



Merchants' Refrigerating Co., New York
G. B. Snook & Sons, Architects

The matter of handling goods by conveyors is still a debatable point among cold storage building operators. Some things, such as sides of beef and material of similar character, are now handled on overhead tracks. There have been some houses where belt and live roll conveyors can be used. There are also some installations of vertical conveyors, for both loading and unloading the room. Where wages are high, it is economical to use the largest amount of conveying machinery possible. As this equipment is relatively expensive, however, it requires a very careful analysis of the entire problem, as it is never economical to use expensive machinery unless it can be kept moving a large part of the time. There are many and varied interests to be satisfied in an intricate building of this kind. The heads of the shipping and receiving departments, the storage departments, the accounting department and the general manager frequently have very different ideas as to the proper design and layout of the building. It is usually the major problem of the designing engineer to analyze the opinions of the various executives, giving due weight to the ideas of the men who have to do the work, but being careful not to sacrifice the efficiency of the complete unit for slight additional gains of a single department. Whether or not the proper solution of these various factors is obtained frequently makes the difference between a good and economical, or very bad and inefficient design in the completed building, and a pleased or a displeased client.

Arrington Cold Storage Co.
Arrington, Va.
The Ballinger Company, Architects and Engineers

INFILTRATION AND THE HEATING PROBLEM

BY

P. E. FANSLER

INFILTRATION and exfiltration combine to make a formidable problem for the architect; that is, if he has consideration for the comfort and for the pocketbook of his client. Consider a house of ordinary construction, an outdoor temperature of zero, and a high north wind. Air at zero temperature infiltrates through the north side of the house, is heated, and exfiltrates through the southern walls, windows and doors. Until recently very little reliable information has been available as to the demand on the heating plant due to infiltration. Indeed, it is hard to believe the actual facts, now that they are known, because they seem to be out of all reason.

About two years ago the research committee of the American Society of Heating and Ventilating Engineers determined to solve the infiltration riddle and replace, with the results of actual tests, figures that were little more than guesses. The Bell Telephone Company of Missouri had erected a new and high building in St. Louis and offered the use of one of its upper floors to the Society. The elaborate equipment developed in the research laboratory of the Society was set up in St. Louis so that actual infiltration could be determined. One reason for accepting this offer was that steel windows of the latest type had been used, and infiltration data on them were of great value because of the increasing use of this type of window. The testing apparatus installed consisted of a large rectangular metal box, open on one side with a device fixed at the center of the opposite side so that orifices of desired diameters could be used. The box was fastened to a wall area containing the window to be tested, and the periphery carefully calked so that the contact was airtight. An arrangement of a very delicate pressure gauge permitted the taking of readings that determined the flow of air through the orifices, so that air infiltered through the window cracks passed through the orifices and was quantitatively determined.

One of the interesting stories of practical research is that of these investigators who waited, day after day, for wind of desired velocities and directions, so that practical determinations could be made. But the wind blew from every direction but that desired. Finally, exasperated, they exercised typical ingenuity by fitting a casing to the window, with a pipe to which a blower was attached. Thus it was possible artificially to simulate wind pressure of any desired velocity, regardless of the caprices of nature. Valuable data were obtained, showing the extent to which these metal windows could be expected to limit infiltration. From the knowledge we have on this subject, it is evident that a building may require more heat when the thermometer is well above zero and with a high-velocity wind blowing than for a condition where the temperature is below zero and the air at rest. For this reason the average wind velocities of the three months of greatest heating load,—December, January and February,—must be taken into consideration when determining heating requirements. Not only velocity, but direction, is a factor in figuring infiltration as well as heat loss. Obviously, it is impossible to set up test equipment that will exactly simulate natural conditions of "wind and weather." A controllable pressure that is equivalent to a known wind velocity *at right angles to the plane of the window* can be provided, but windage *against* a window is seldom uniform and fixed in direction.

In order to picture the situation and to show how the architect can control it to the lasting benefit of his client, let us consider a living room, as shown in Fig. 5, extending across one end of a house. Essential data are given on the sketch. From values actually determined by tests made in the research laboratory of the American Society of Heating and Ventilating Engineers, let us build up a tabulation for various wind velocities, showing: (a) the infiltration through the uncalked crack around the frame *of the north windows only;* (b) the radiation required to heat this inflowing air to 70°; (c) the infiltration through the crack around the sash, including the meeting rail crack; (d) the radiation necessary to heat this volume of air; (e) the total infiltration on account of these windows; (f) the total radiation necessary because of *infiltration* around this group of windows and its frame. Bear in mind that we are not considering the loss of heat through the window glass. The results, Table I, are startling.

With an assumed wind velocity of 5 miles an hour,—a wind condition hardly noticeable,—there will blow into this room, through the north windows alone, in one hour, almost enough air, at zero temperature, to entirely fill the room. At least 15 square feet of radiation will be necessary to heat this air to 70°. With a 10-mile wind the infiltration will be 6,535 cubic feet, and 35 square feet of radiation will be needed. Increasing the wind velocity to 20 miles an hour brings the infiltration to almost four times the volume of the

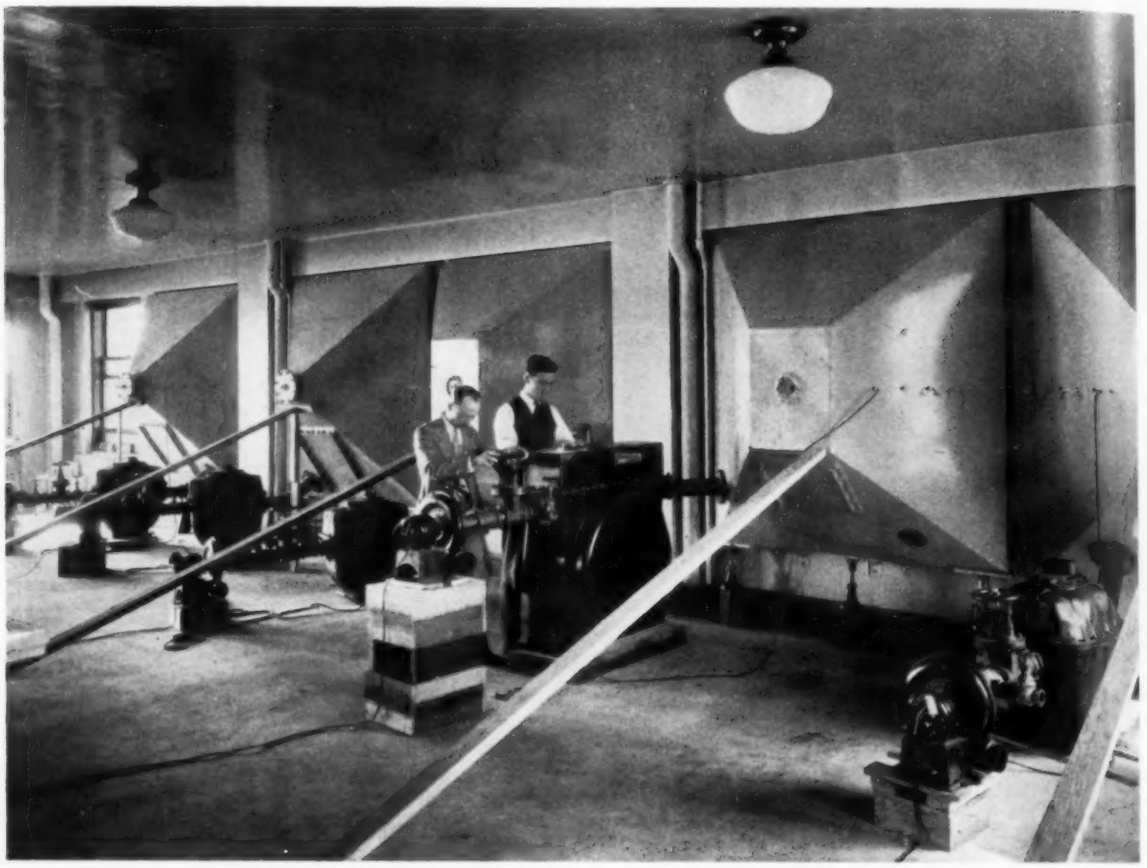


Fig. 1. Measuring Infiltration in a Field Laboratory Established in an Office Building

room, and the radiation to 61 square feet, and if we consider a 30-mile wind,—no stranger during the bitter cold of December and January,—the leakage through this window will change the air in the living room every *11 minutes*. Under this condition heat must flow continuously from a huge radiator,—100 square feet,—to heat the incoming air, and coal must be burned at the rate of 3 pounds per hour, or nearly 75 pounds per day, just because of this "leaky" window. To show what can be saved by carefully installed stripping, another portion of the table has been computed. It is evident that the reduction in radiation requirement,—100 square feet with no weatherstripping and a 30-mile wind, reduced to 33.8 square feet,—is so material as to warrant serious attention to the problem. This example admittedly is extreme, as a 30-mile wind is considerably in excess of normal winter winds, but such a wind is not uncommon, and should be taken into consideration.

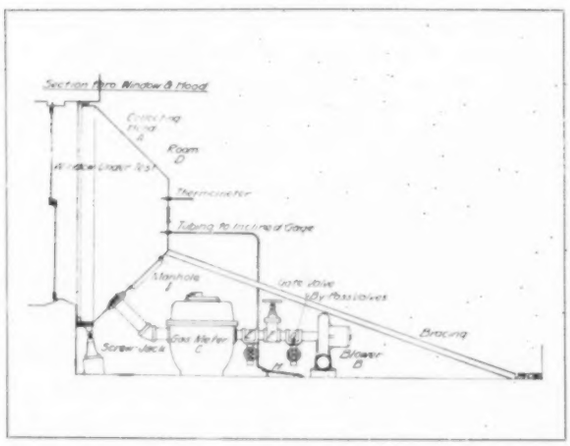


Fig. 2. Diagram Showing the Arrangement of Apparatus Used in the Office Building Tests

It must be remembered that one part of this so-called loss is entirely unnecessary where attention is paid to details in construction. Practically all leakage around window frames can be stopped by proper calking. This is true whether wood or metal windows are considered. Taking the case of the room and windows under discussion, we have found a radiation requirement of 100 square feet for the four windows, with a 30-mile wind. Of this, 10.4 square feet represents frame leakage, and all of this 10 per cent of the whole can be prevented if the frame is well calked. By proper weatherstripping, the

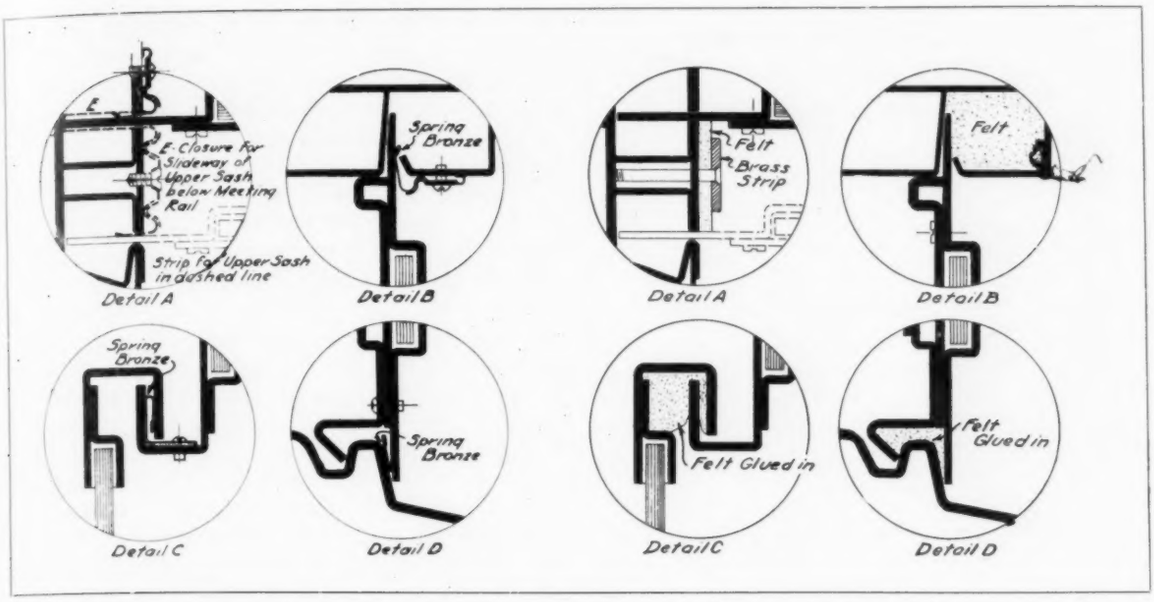


Fig. 3. Design and Construction Details of Two Commercial Types of Weatherstripping Applied to Metal Windows Under Test

radiation, as we have seen, can be reduced to 33.8 square feet,—a gross saving of 76 per cent. Surely economies of this order demand, in every case, attention and analysis by the architect.

Essential data developed through the tests at St. Louis[1] are presented here in tabular form in Table 2. The values have been reduced by 20 per cent from the figures shown by the tests because, while they are derived from actual tests, they do not represent ordinary conditions, where pressure is built up in rooms, reducing the infiltration rate by about one fifth. Of course, all the air that blows into the windward side of a house exits from the leeward openings and cracks, frequently accelerated by suction created as the result of the wind. Consequently, when arriving at the total demand, only one half of the radiation due to infiltration loss (as computed for all exposed walls of a building) need be added to the radiation required to offset the direct heat loss.

In studying infiltration losses, research engineers have differentiated between "crack" and "clearance." The drawing, Fig. 6, will make this clear. The crack is taken as one half the difference between the width of the frame and the width of the sash. The clearance is the difference between the width of the stile and the thickness of the sash. One of the interesting findings, in reseach[2], is the fact that increasing the crack around the perimeter of a plain sash did not materially increase the leakage, and that weatherstripped sash, while permitting much less leakage, showed a small increase in leakage with increase in crack. Tests on a plain wood window, with various clearances, brought out the curious fact that the size of the crack around the perimeter has no appreciable effect on the leakage. Consequently the data developed can be applied to any window of the type tested with a crack of from 1/16 of an inch to ¼ of an inch. It has not been found practical to install wooden windows with cracks of less than 1/16 of an inch, and as the windows age and dry, the cracks increase in width. A typical set of test curves for a plain double-hung

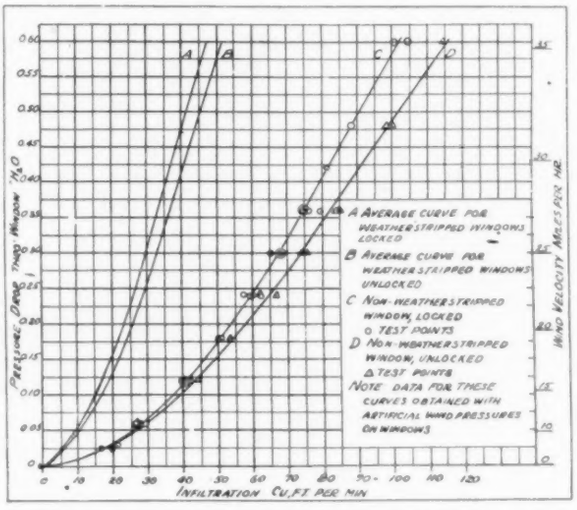

A Average curve for weatherstripped windows locked
B Average curve for weatherstripped windows unlocked
C Non-weatherstripped window, locked
o Test points
D Non-weatherstripped window, unlocked
Δ Test points
Note: Data for these curves obtained with artificial wind pressures on windows
Infiltration Cu. Ft. per min
Wind Velocity Miles per Hr.

Fig. 4. Graph of Infiltration Through Metal Windows, Locked and Unlocked, With and Without Weatherstripping

[1]Note 1.—"Saving Heat in Skyscrapers," a paper read at the 1928 annual meeting of the A. S. H. & V. E. by F. C. Houghten and M. E. O'Connell.

[2]Note 2.—"Effect of Frame Calking and Storm Windows on Infiltration Around and Through Windows," a paper presented at the 1928 semi-annual meeting of the A. S. H. & V. E., by W. M. Richtmann and C. Braatz.

Fig. 5. Plan of Living Room with Four North Windows, for which Infiltration Losses are Computed (Table 1), to Show the Importance of Reducing Infiltration to a Minimum

wood window is shown in Fig. 7, from which is evident the tremendous increase in leakage with increase in sizes of crack and clearance.

Referring to Table 3, we can readily determine the economies of weatherstripping. For New York and vicinity the average wind velocity during the three months of December, January and February is 13.3 miles. The nearest to this figure, in Table 3, is 15 miles. At this velocity the table shows that 0.65 square feet of radiation is required to take care of the loss due to infiltration through 1 linear foot of crack. If the window were weatherstripped, the corresponding radiation requirement would be 0.12 square feet, showing a saving of 0.63 square feet of radiation. A fair estimate of cost for a heating system would be $2 per square foot of installed radiation, and the saving effected through weatherstripping can safely be taken as one half of this, or $1. As the weatherstrip probably could be put on for less than 50 cents a foot, there is no question as to the economy. Turning to the question of annual saving, we get another angle of the problem. If we assume 5,300 degree-days heating load, we will find a requirement of about 70 pounds of coal per square foot of radiation, per heating season. At $16 per ton, the annual saving, due to weatherstripping, would be about 30 cents, or almost enough to pay for it. With the data here given, and by applying the method of fuel determination described in the article on "Determining Fuel Requirements by the Degree-Day Method" in the February, 1929 issue of THE ARCHITECTURAL FORUM, the archi-

TABLE 1.—CALCULATIONS OF INFILTRATION AND CONSEQUENT RADIATION REQUIREMENTS OF WINDOWS SHOWN IN FIG. 5

Wind Velocity	CRACK AROUND FRAME				WINDOW CRACKS (No Weatherstripping)			
	Factors per Ft. Uncalked Crack Around Frame		Total for Frame for 4 D. H. Windows Having 36 Lin. Ft. Frame Crack		Factors per Ft. Crack Around Sash*		Total for 4 D.H. Windows With 73 Lin. Ft. Crack	
Miles per Hour	Leakage, Cu. Ft. Per Hr.	Sq. Ft. Radiation Required	Leakage, Cu. Ft. Per Hr.	Sq. Ft. Radiation Required	Leakage, Cu. Ft. Per Hr.	Sq. Ft. Radiation Required	Leakage, Cu. Ft. Per Hr.	Sq. Ft. Radiation Required
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
5	1.41	0.007	48	0.3	39.3	0.21	2860	15.2
10	11.3	0.06	405	2.16	84.9	0.45	6180	32.8
20	31.1	0.16	1110	6.1	161.0	0.85	11750	55.2
30	53.6	0.28	1925	10.4	233.0	1.23	16950	89.6
Wind Velocity	WINDOW CRACKS (Weatherstripped Window) Quantities same as (6), (7), (8) and (9)				Total for Frame and Window Infiltration		Total for Infiltration, Frame and Weatherstripped Window	
Miles per Hour	Leakage, Cu.Ft. Per Hr.	Sq. Ft. Radiation Required	Leakage, Cu. Ft. Per Hr.	Sq. Ft. Radiation Required	Leakage, Cu. Ft. Per Hr.	Sq. Ft. Radiation Required	Leakage, Cu. Ft. Per Hr.	Sq. Ft. Radiation Required
	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
5	3.00	0.016	219	1.2	2908	15.3	267	1.5
10	11.7	0.062	854	4.5	6585	35.0	1259	6.7
20	34.9	0.19	2540	13.8	12860	61.3	3650	19.9
30	59.6	0.32	4340	23.4	18875	100.0	6265	33.8

*Including meeting rail. Allowing for 1/16-inch crack and 7/64-inch clearance.

tect can determine the saving effected for his client by calking window frames, providing for tight windows, and by having weatherstripping installed.

Attention should be directed to the fact that the best types of weatherstripping carelessly applied may fall far short of providing the immunity from infiltration claimed in the printed matter of the manufacturer. The technique of application is of as great importance as the excellence of design or quality of manufacture. Again, some defect quite apart from the weatherstripping may defeat its purpose. A certain living room, for example, had two French doors in the west wall. The leakage was so great that it was impossible to maintain a 65° temperature when a wind was blowing from the north or west. When a real "norther" was blowing, a candle flame was frequently blown out at a distance of 3 feet from the crack between the door edges. Metal weatherstripping was applied, and, as the house was rented, the owner tried to economize by awarding the contract on a price basis. When the next "norther" came, it was found that the infiltration had materially been reduced, but that the candle flame was in danger 1 foot from the tops of the doors! Investigation proved that the doors were warped to such an extent that tight weatherstripping was impossible. It all goes to show the dependent character of the various component parts of a building, and that it does not pay to skimp in any particular.

In many parts of the country storm sash are in common use, and it is interesting to read the conclusions drawn by W. M. Richtmann and C. Braatz, of the faculty of the University of Wisconsin on an exhaustive study of frame calking and storm window application[2]. They say that: "The infiltration through the crack between a brick wall and window frame is a very important factor in calculating the infiltration into a room. However, this source of leakage can be practically eliminated by the application of some type of calking compound to the crack. The application of storm sash does not materially decrease the infiltration of a tight-fitting window, but it does give a large saving if the crack and clearance of the window are large. The application of a wool strip between the frame and storm sash reduced the infiltration appreciably. The storm sash applied by means of four turn-buttons reduced infiltration much more than those applied by means of a hook-and-eye suspension arrangement. The infiltration through the crack between a brick wall and window frame for a plastered wall is about 40 per cent of that through the same crack on a plain wall. This leakage may be as great as the leakage through the sash perimeter of the window."

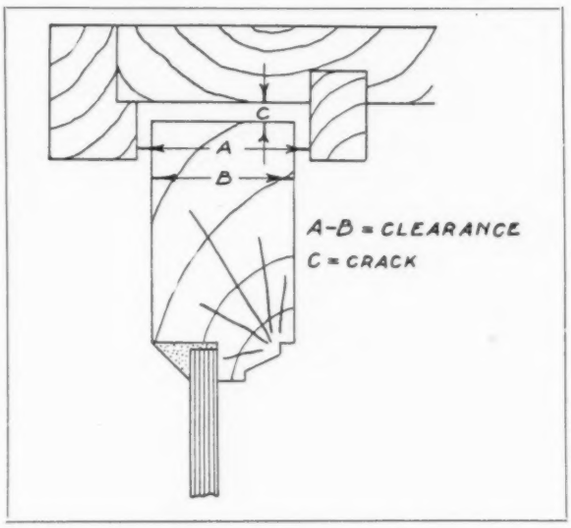


Fig. 6. Sketch Showing the Distinction Between "Crack" and "Clearance"

Turning, now, to the modern steel window, much used in industrial buildings and residences, we find some valuable data resulting from a series of tests made at the University of Michigan by Professor J. E. Emswiler and W. C.

TABLE 2—INFILTRATION THROUGH DOUBLE-HUNG METAL SASH WINDOWS PER FOOT OF CRACK

Wind Velocity Miles per Hour	Non-Weatherstripped Window, Locked			Non-Weatherstripped Window, Unlocked			Weatherstripped Window, Unlocked		
	Leakage, Cu. Ft. per Hr.	Heat Loss B.t.u. per Hr. 0–70° Fahr.	Sq. Ft. Radiation	Leakage, Cu. Ft. per Hr.	Heat Loss B.t.u. per Hr. 0–70° Fahr.	Sq. Ft. Radiation	Leakage, Cu. Ft. per Hr.	Heat Loss B.t.u. per Hr. 0–70° Fahr.	Sq. Ft. Radiation
5.0	20.4	25.7	0.10	20.4	25.7	0.10	6.5	8.2	0.03
10.0	45.4	57.2	0.24	47.3	59.6	0.25	18.6	23.4	0.10
15.0	70.4	88.6	0.37	74.0	93.1	0.39	31.5	39.7	0.17
20.0	96.3	121.2	0.51	103.8	130.7	0.55	46.0	57.9	0.24
25.0	125.0	157.6	0.66	137.1	172.8	0.72	60.2	75.8	0.32
30.0	153.8	193.4	0.81	170.4	215.0	0.90	76.0	95.6	0.40
35.0	186.8	236.0	0.98	212.0	267.5	1.11	94.5	119.0	0.50

Values for practical use; average test values reduced by 20 per cent to allow for building up of pressure in room, etc.

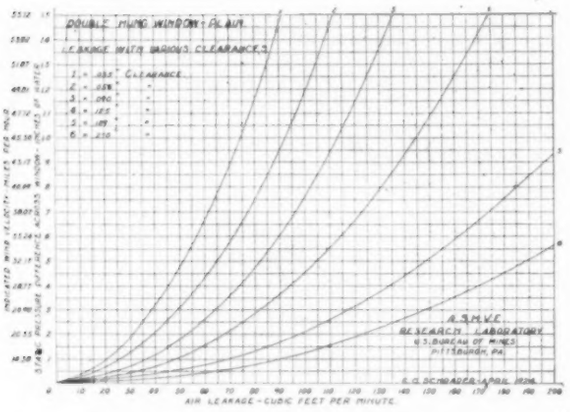


Fig. 7. Graph Showing Leakage Through Plain Wood Window with Various Clearances

Randall[3]. In addition to carrying out a study of leakage through the cracks of rolled steel windows, a field study was made to determine the crack widths found in practice. Measurements of more than 1,600 steel windows are tabulated in Table 4, from which it will be seen that much less air can pass through the cracks of steel windows than through corresponding openings around conventional unweatherstripped wood sash. The tests indicated that when steel windows are calked with mastic, as is the common practice with residential casements, heavy section casements, heavy casement-section projected, and possibly architectural projected, or grouted with cement, as is the common practice with industrial pivoted windows, the frame leakage is negligible.

[3]Note 3.—"The Weathertightness of Rolled Section Steel Windows," presented at the 1928 meeting of the A. S. H. & V. E.

In figuring wood windows, the frame and the other leakage are to be added to the crack leakage to obtain the total. In the steel window there will be little or none of the frame leakage often found in wood windows, because the steel framing is usually installed in the opening with grout or mastic, and the co-efficient of expansion of steel is so near that of building construction that the bond is maintained intact. Cracks at mullions and at contacts where the windows are attached to the steel framework are found to give negligible leakage if care is exercised in installation.

Professor Emswiler brings out an interesting and important point in connection with high buildings. He says: "Even without any wind, a difference of temperature inside and outside will cause the pressure state inside to be less than that outside at the ground, and greater near the roof, and inflow will occur at lower windows and outflow at upper windows. If the building is tall and open throughout from bottom to top, or if arranged in stories in free communication from one to another, and if the temperature difference is great, the pressure difference created at a point near the ground and also at a point near the roof may be considerable. Thus in a building 200 feet high with 70° Fahr. difference in temperature, this force alone, causing inflow at the ground and outflow at the top, may easily exceed 0.2 inches of water, which is the equivalent of a 20-mile wind. If the building is multiple-storied, and if there is absolutely no communication between stories, then the force of temperature difference is effectually nullified, or rather reduced

TABLE 3—INFILTRATION THROUGH DOUBLE HUNG WOOD SASH WINDOWS

	Wind Velocity Miles per Hour	Per Foot of Uncalked Crack Around Frame*			Per Foot of Crack around the Sash including Meeting Rail for Cracks of 1/16-in. and 7/64-in. Clearance, Window Unlocked					
					Plain Non-stripped Wood Window			Aver. Weatherstripped Window		
		Leakage, Cu. Ft. per Hr.	Heat Loss B.t.u. per Hr. 0–70° Fahr.	Sq. Ft. Radiation	Leakage, Cu. Ft. per Hr.	Heat Loss B.t.u. per Hr. 0–70° Fahr.	Sq. Ft. Radiation	Leakage, Cu. Ft. per Hr.	Heat Loss B.t.u. per Hr. 0–70° Fahr.	Sq. Ft. Radiation
Values for practical use; average test values reduced by 20 per cent to allow for building up of pressure in room, etc.	5.0	1.41	1.77	0.007	39.3	49.5	0.21	3.00	3.80	0.016
	7.5	6.36	8.08	0.034	62.8	79.2	0.33	6.82	8.60	0.036
	10.0	11.3	14.3	0.060	84.9	107.0	0.45	11.7	14.9	0.062
	15.0	22.6	28.7	0.12	124.0	157.0	0.65	22.9	29.1	0.12
	20.0	31.1	39.4	0.16	161.0	203.0	0.85	34.9	44.3	0.19
	30.0	53.6	68.2	0.28	233.0	294.0	1.23	59.6	75.6	0.32
	40.0	76.0	96.5	0.40	309.0	390.0	1.63	87.8	111.0	0.46
	50.0	88.9	114.0	0.48	390.0	492.0	2.05	117.0	148.0	0.62

Notes.—*A.* This table is approximately correct for cracks up to ¼-in.

B. The values given for the plain non-stripped wood window and for the weatherstripped window include the "elsewhere" leakage through the frame, but not the leakage through the uncalked crack around the frame. If the frame is to be left uncalked, the loss under that heading should be included in the heat loss calculations.

*Practically all leakage around frames can be stopped by proper calking.

to an amount proportional to the height of a single story. However, there is always some communication by means of stairs and otherwise, so that the force of temperature difference is always operative in some degree."

It is worth comment that the quantity of infiltration is dependent upon things other than wind velocities and cracks. It is obvious that the outer air cannot be forced through the cracks of a building on the pressure or windward side unless the same volume of air passes out through the leeward side. Therefore the interior layout of the building and the character of its occupancy must enter into the problem. If a room on the side of excessive winter exposure is seldom used, and if the communicating doors are generally kept shut, the infiltration will be slight regardless of the weather-tightness of its walls and windows. For this reason, it might be in order to weatherstrip interior doors as a means of decreasing infiltration. By the same token, open transoms tend to increase infiltration, as do chimneys from fireplaces and kitchen vents, especially if supplemented by electric fans. An interesting example came up in connection with a large house where the kitchen was vented with draft produced by an electric fan. The ventilation was entirely adequate, but it was not realized that the infiltration, some 400 cubic feet an hour, required the use of more than 1,000 gallons of oil per heating season.

An interesting point came to light recently when calculations were made of heat losses and infiltration for a house located near New York. Three rooms, forming one long and one short adjoining wall, were considered (Fig. 8). The radiation requirements were computed for the condition where the long wall faced north and the short wall, east. The house then was assumed to be rotated clockwise, so that the long wall faced northeast and the short wall, southeast, and the amount of radiation was determined. This process was repeated, with 45° steps throughout the circle. It was found that the requirements varied 50 per cent.

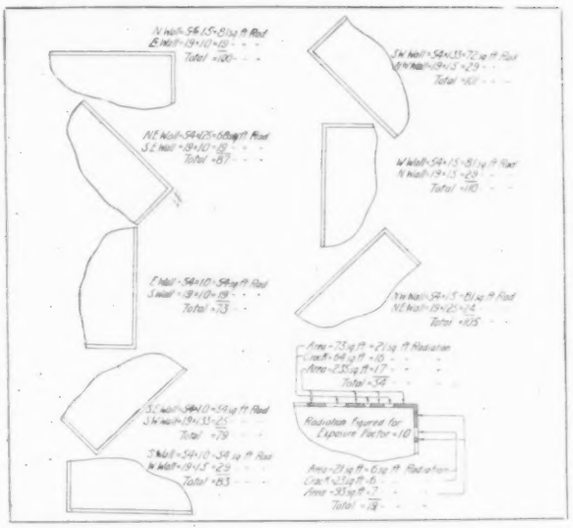


Fig. 8. Diagram Showing Variation in Radiation Required for Various Exposures

There is a growing tendency on the part of the builders to install insulation, weatherstripping, and the other elements that may add to the first cost of a house but which reduce the annual cost of operation, and which frequently provide for more comfortable occupancy. As has been suggested, these refinements may bring about savings in other elements that completely offset their cost. It is entirely possible, in the construction of a small house, to spend $500 for insulation and weatherstripping and save $300 or $400 in the cost of the heating plant. At the same time, a more comfortable house is insured for summer occupancy, and a more salable property is produced.

TABLE 4—MEASURED CRACK WIDTHS OF STEEL WINDOWS IN SERVICE

Building Designated by Letter	Type of Window	Number of Ventilators Having Crack Width Indicated Which Represent the Average of a Number of Trials at Edges of Ventilators							
		0.006″	1/64″	1/32″	1/16″	1/8″	1/4″	Total No.	Aver. Crack
A (U. of M.)	Heavy section casement	7	28	25	4	4	..	68	1/32″ −
B (Detroit)	Residential casement	56	39	6	1	..	..	102	1/64″ −
C (U. of M.)	Heavy casement section projected	..	8	12	9	7	..	36	3/64″ +
D (U. of M.)	Heavy casement section projected	58	214	6	10	2	..	290	1/64″
E (U. of M.)	Heavy casement section projected	77	127	10	..	..	..	214	1/64″ −
F (U. of M.)	Industrial pivoted	..	7	19	30	35	6	97	3/32″ −
G (Detroit)	Industrial pivoted	16	45	46	27	11	15	160	1/16″ −
C (U. of M.)	Commercial projected	..	..	..	..	128	103	231	3/16″
H (U. of M.)	Commercial projected	..	80	24	6	..	..	110	1/64″ +
I (U. of M.)	Architectural projected	43	41	5	21	..	..	110	1/64″ +
J (U. of M.)	Architectural projected	6	53	13	10	6	..	78	1/32″ −
K (U. of M.)	Architectural projected	76	90	13	..	..	..	180	1/64″ −

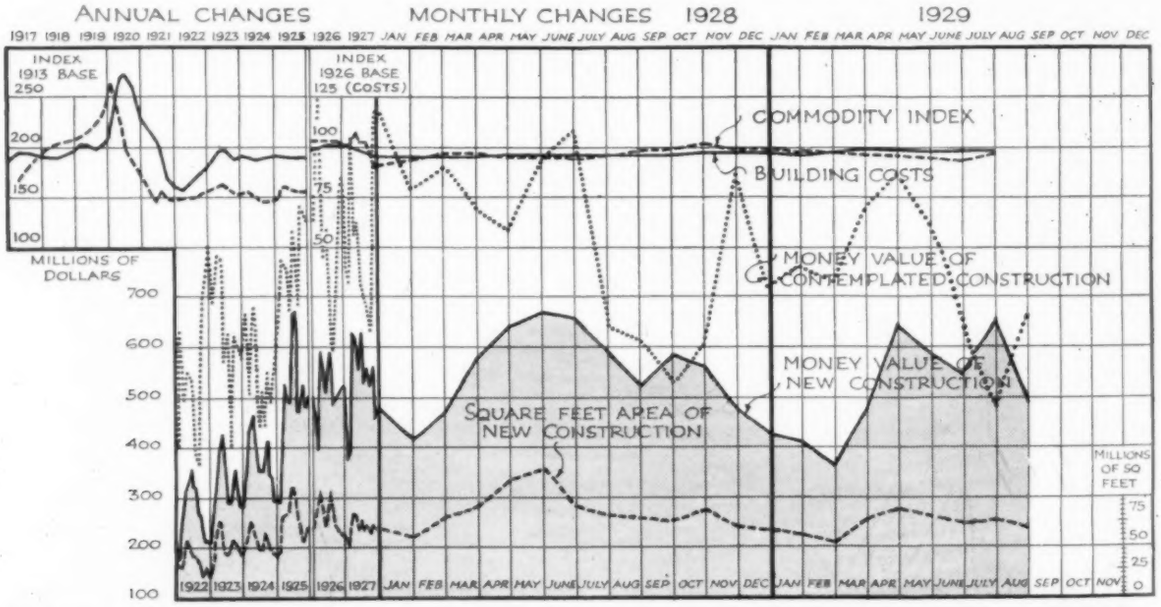
THE BUILDING SITUATION

A MONTHLY REVIEW OF COSTS AND CONDITIONS

IN view of the fact that contracts awarded for construction during the month of July represented the second highest monthly total recorded to date, it is not surprising that August construction shows a decided falling off in several of the areas of the United States. The August contract total for the 37 states east of the Rocky Mountains amounted to $488,882,400, according to the F. W. Dodge Corporation, a decline of 25 per cent from the July total and a decline of 5 per cent when compared with that of August of last year. This brings the total of the first eight months of this year up to $4,-156,865,300, a decrease of 9 per cent from the corresponding figures of 1928. In the district comprising New York state and northern New Jersey, value of August contracts amounting to $94,506,000 was 57 per cent below the July figures and 26 per cent below those of August, 1928. For the first eight months of the year this district showed total contracts awarded amounting to $1,001,911,700, a decrease of 16 per cent.

Construction work started in the New England states totaled $33,459,900 during August, a figure 21 per cent below that of the preceding month and 14 per cent below that of August, 1928. The construction total in this district for the first eight months of this year amounted to $283,950,100, which is 12 per cent below the first eight months of 1928. In the middle Atlantic states construction fell off 39 per cent as compared with July. The August total was $45,-595,600. This also represents a decrease of 11 per cent from that of August a year ago. For the eight months of this year the total of $508,-393,700 was 5 per cent below that of 1928.

The central western and northwestern states showed a comparatively small decline in August. In the central west, with contracts awarded amounting to $153,170,800, the decrease was 4 per cent from the July figures and 8 per cent from the August, 1928 total. For the eight-month period this district showed new construction started to the amount of $1,225,572,900, a decrease of 11 per cent from that of the first eight months of last year. The total of $8,303,100 for August construction in the northwestern states was 6 per cent below the preceding month and 20 per cent below August of last year. However, construction for the first eight months of 1929, with a total of $65,734,500, was 21 per cent ahead of the corresponding period of 1928.


ANNUAL CHANGES
MONTHLY CHANGES 1928
1929
1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 JAN FEB MAR APR MAY JUNE JULY AUG SEP OCT NOV DEC JAN FEB MAR APR MAY JUNE JULY AUG SEP OCT NOV DEC
INDEX 1913 BASE
INDEX 1926 BASE 125 (COSTS)
COMMODITY INDEX
BUILDING COSTS
MONEY VALUE OF CONTEMPLATED CONSTRUCTION
MONEY VALUE OF NEW CONSTRUCTION
SQUARE FEET AREA OF NEW CONSTRUCTION
MILLIONS OF DOLLARS
MILLIONS OF SQ FEET

THESE various important factors of change in the building situation are recorded in the chart given here: (1) *Building Costs.* This includes the cost of labor and materials; the index point is a composite of all available reports in basic materials and labor costs under national averages. (2) *Commodity Index.* Index figure determined by the United States Department of Labor. (3) *Money Value of Contemplated Construction.* Values of building for which plans have been filed based on reports of the United States Chamber of Commerce, F. W. Dodge Corp. and *Engineering News-Record.* (4) *Money Value of New Construction.* Total valuation of all contracts actually let. The dollar scale is at the left of the chart in millions. (5) *Square Foot Area of New Construction.* The measured volume of new buildings. The square foot measure is at the right of the chart. The variation of distances between the value and volume lines represents a square foot cost which is determined, first by the trend of building costs, and second, by the quality of construction.

ELECTRICAL WIRING LAYOUTS FOR OFFICE BUILDINGS

BY

NELSON C. ROSS

ELECTRICAL ENGINEERS, RICHARD D. KIMBALL CO.

THE electrical wiring layout for an office building will be necessarily influenced by the size and location of the building, the type of construction, and the completeness of the equipment desired, and also upon whether the building is to be occupied wholly by the owner or is to be wholly or partially for rental.

In general, the wiring layout will include separate wiring systems for the control of lighting and power services; conduit raceways for the development of the telephone and miscellaneous low tension office equipment; protective wiring, including fire alarm and watchman's clocks, together with the required distributing switchboards, panelboards, wire closets, motor, equipment, and lighting fixtures, etc.; and the final connection with the service mains.

Construction. With the smaller office buildings of second class construction, and where it is unlikely that the walls and partitions will be changed to meet the requirements of new tenants, the use of B X armored wire is permissible where the circuits occur in wood construction. With the use of B X armored wires, however, standard 4-inch conduit outlet boxes should be used on all branch circuits for all outlets. These boxes are fitted with the regular fixture receptacle and switch covers, the armored wires entering the boxes with approved clamp type box connecters and lock nuts. With the use of B X, construction "troubles" will nearly always occur at the "outlets" and are mainly due to the use of too small outlets or ceiling plates, the improper insulation of splices, and the crowding of the wires and splices in the outlet boxes.

Expense permitting, however, rigid conduits should always be used for both high- and low-tension wiring and for all types of building construction, since, with the use of rigid conduit properly installed, there is ample room for the installation of wires without crowding, and the wires may be withdrawn, replaced, or added to, at will without the necessity of cutting walls or construction.

With all buildings of first class construction, or where wires must be installed under cement floors, in masonry, or in damp locations, the use of rigid conduits for all services is obligatory.

Preliminary Information. Upon the commencement of the work, a rough approximation should be made of the connected load for both lighting and power services, and such information, together with the rough plot plan, should be given to the public service company, in order that the company may determine the character of the service available for both lighting and power, and also determine the point at which the service cables will enter the building. A copy of the local installation rules of the public service company should also be obtained, as well as any local ordinances governing the installation of the work, and such rules together with the requirement of the "code" should be also ascertained and this information given the telephone company and like service companies, in order that the point of entrance may be determined and the low tension service conduits proportioned for the maximum requirements of the building.

Circuit Wiring. In planning the circuit wiring throughout the office floors, provision should be made for a meter closet on each of the floors. This closet should be located at some central point, and be accessible from the public stair hall or corridor. Panelboards of the lighting system and connecting cabinets of the low tension systems, as well as the terminal cabinets of the public telephone and A.D.T. services, should be installed in these meter closets, and all circuits of all services on the floor should be run back to the meter closet and connect with the respective cabinets, etc.

To facilitate the installation of risers and feeders, meter closets should, as far as possible, be located one over another on the different floors and connected with a vertical wire shaft. The required demensions of the meter closet will depend upon the number of offices served from the closets. With the smaller buildings with some 15 or 25 offices on a floor, a closet floor space of approximately 6 x 8 feet or more may be required. With the larger buildings, the closet space should be increased in proportion.

Where, with large floor areas and the use of one meter closet, branch circuits exceed 125 feet in length, two or more meter closets should be considered for each floor, these closets being so spaced that the average length of the branch circuits will not exceed 100 feet. With the use of more than one meter closet on a floor, each closet should be made to serve a definite zone, and all branch circuits of all services within the zone should be run back to, and connected with the respective meter closets. Where a building is to be occupied wholly by one tenant, less space may be required in the meter closets, as individual office meters will not be required.

In planning the circuit wiring throughout the offices and rented spaces, provision must not only

be made for fixed ceiling outlets, and outlets in permanent walls and columns, etc., but a flexible arrangement of conduit outlets, and switches, etc. must be had, these being interconnected to permit of the ready extension of circuits, and the metering of one or any number of offices from a single meter as desired.

In general, the outer building walls, corridor bearing walls, columns, and stair enclosures, being fixed, may be equipped with sub-panels, outlets, switches, etc. Conduits and outlets, however, should, in general, be kept clear of partition walls, permitting the removal and relocation of the partitions without interference with electric conduits and outlets.

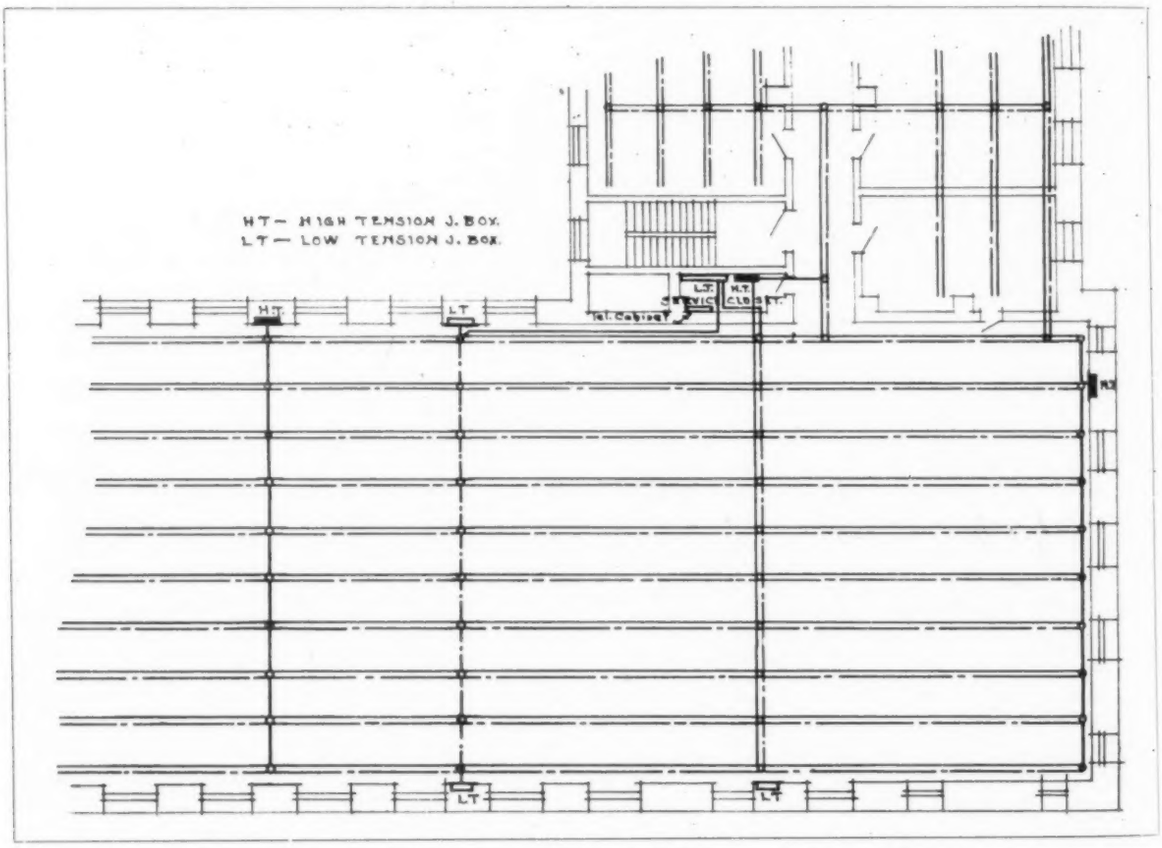
The spacing of outlets for ceiling fixtures throughout the offices will be influenced by the height of the ceilings and the location of the exposed beams. In offices with floor areas of approximately 12 x 20 feet, two ceiling outlets will give satisfactory results. Where the office width exceeds 12 feet, it is advisable to use four outlets. In larger areas, spacing of ceiling outlets should not exceed the hanging height of lighting unit.

It is difficult to determine the required lighting intensity for different offices, as this will be influenced by the class of work carried on and the individual desires of the tenants. The code rules call for a definite number of watts per square foot of floor area, but this value will be far exceeded in practice. It is well to provide additional room in the conduits, as well as extra circuits on the panelboards to permit of the extension of additional branch circuits if they are required.

In practice, no office circuit should be fully loaded, and it is seldom that more than two or three ceiling outlets are connected on a circuit from the panelboard. Outlets for the use of wall fans should be wired on separate circuits from the lighting, and convenience outlets should be also wired on separate circuits with not more than two convenience outlets connected to the branch.

In general, an office of approximately 12x24 feet of floor area will require two ceiling outlets connected on one branch circuit, and under local switch control; four convenience receptacles, properly spaced and wired on two circuits, permitting the later extension of additional circuits from the outlets for possible special equipment; and two receptacle outlets on walls or columns, 7 feet, 6 inches above the floor (wired on one circuit) to provide for wall fans.

Where it may be determined that certain office spaces may be rented for barber shops, hair dress-



Typical Under-floor Duct System Giving Full Coverage in Large Office Space

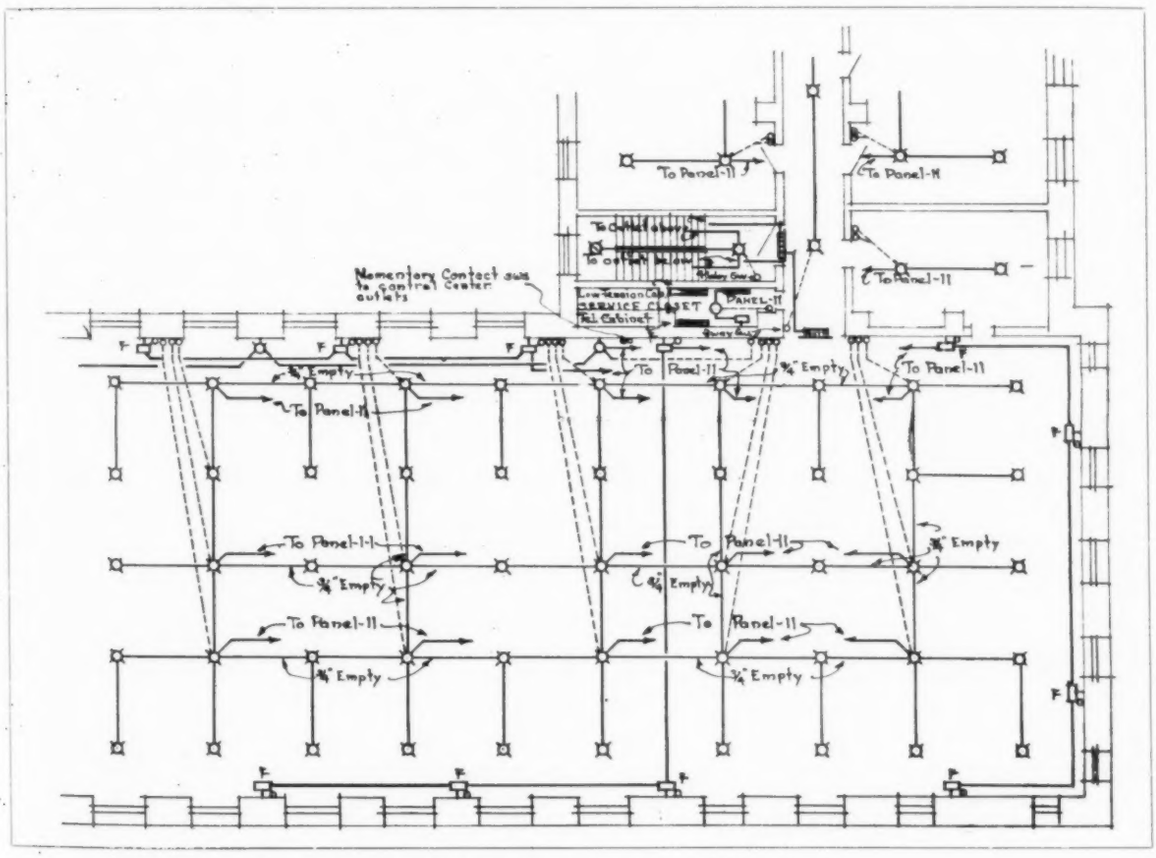
ing parlors, or beauty parlors, and where high wattage equipment may be required, it is good practice to provide an empty conduit (of not less than 1¼ inches) from the panel cabinet in the meter closet to each such office space to provide for possible future loads, the conduit to be capped at a point near ceiling convenient for future extension.

For the development of the lighting circuits throughout larger areas, one method of circuit wiring employs the use of one ceiling outlet in the center of each bay, this outlet fed from two full circuits from the panelboards in the meter closet. With the development of the "space," circuits are extended from the center outlets using a metal moulding to additional ceiling outlets, switches, and convenience receptacles, as may be required. These center outlets may be further cross-connected using empty ¾-inch conduits forming a conduit network in the ceiling construction through which future circuits may be developed.

A second method employs the use of uniformly spaced outlets throughout each of the bays, at approximately from 8- to 10-foot spacings, (usually four outlets to the bay) and each two outlets fed from a circuit from the meter closet; switch legs are dropped from the outlets to switches on columns or on permanent walls. Receptacle outlets are also provided on columns and permanent walls, setting them 18 inches above the floor for general office use and 7 feet, 6 inches above the floor where used for wall fans. Where an underfloor duct system is not used, the conduits feeding the receptacle outlets should be run in the floor slab. Added flexibility may be secured by the use of junction boxes, one in each bay section, these being set in columns at a point near the ceiling, the feeding conduit passing from the meter closet through the junction boxes to the outlets, the junction boxes in turn being connected together with empty conduits, thus permitting the interconnection of the office circuits.

Public Circuits. Public circuits will include all wiring throughout corridors, stair halls, general toilets, elevator lobbies, outside lighting, public rooms, etc. These circuits should be run back to the meter closets on the respective floors and connected to the public service panelboards in the meter closets, these panelboards controlling from the public feeders, and metering from the building meters on the distributing switchboard.

Corridor lighting outlets may be spaced to conform to the ceiling design, and with flat ceilings


To Panel-11
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¾" Empty

Lighting Fixtures Properly Spaced to Illuminate a Large Open Office Area

will be spaced approximately 20 feet apart. Corridor lighting may be controlled from local switches in the corridors, in group from the meter closets, or from remote control switches in the office of the superintendent, or by means of time switches as desired. With the use of remote control or time switches, however, the corridor and stair lighting should be double-circuited, with the main illumination under the master control, and with the second or emergency circuit controlling part of the illumination from local three-way switches on the stairs and in the corridors. The emergency lighting under the three-way switch control will also act as "watchman's lights," permitting the watchman to "light up ahead" as he makes his rounds. Red lamp receptacles, or illuminated exit signs may be located at all their entrances and also at the exits from the building, these being wired to control from the emergency corridor circuits.

Where illuminated direction signs may be required, flush receptacles may be set at the required height and fed from the public circuits under the control of local switches.

With the use of floodlights or large electric signs, branch circuits may be carried back to the nearest meter closet, connected to feed from a separate panelboard in the meter closet and controlled from separate risers and remote control switches on the switchboard with push-button stations in the office of the superintendent.

Provision must be made for the lighting of the elevator cars from outlets in the hoistways to which the flexible lighting cables of the cars may connect with separate circuits feeding these outlets from the nearest meter closet. Two separate circuits should also be run from the nearest meter closet to each pent house or elevator machine room to provide current for floor-indicating equipment.

Stores. Where the building includes stores, all wiring for them must be independent of the building wiring, each store being wired as a unit under separate service switch and meter control. Where possible, a service room accessible from a public corridor should be provided for the service switches and meters, the whole being fed from separate feeders from the distributing switchboard and from the street side of the building meters. This applies to both power and lighting services. Each store must have an approved service switch with meter loop, the service feeder running from the service switch to the panelboard in each of the stores.

Panelboards may be in the basement with the store lighting controlled from local switches, or they may be in the stores and all circuits controlled from switches on the panelboard. Stores will include ceiling outlets over counters usually spaced on not more than 10-foot centers, floor and fan receptacles, show window and entrance lighting, and provision for electric signs.

Circuits for window and sign lighting may pass from the panelboard to a junction box at or above the transom, the circuits developing from the

junction box (in the window construction) to the outlets. Show window reflectors may be of the flush recessed type or of the surface type. They are as a rule set approximately on 12-inch centers and are wired on two or more circuits, with the circuits controlling alternate reflectors. Outlets should be designed for not less than 150-watt lamps. Each window should also be provided with two base receptacles on independent circuits. In view of the store's possibly requiring power service, or service for the use of electric heating devices of high wattage, it is good practice to make the main lighting feeder for the stores "oversize" and to provide also a power feeder from the distributing switchboard to the meter group, in turn carrying an empty conduit from the meter group to the basement of each of the stores, terminating the conduits in pipe caps in readiness for later extension. Provision for public telephones may be made throughout the stores, using conduits and wire mouldings.

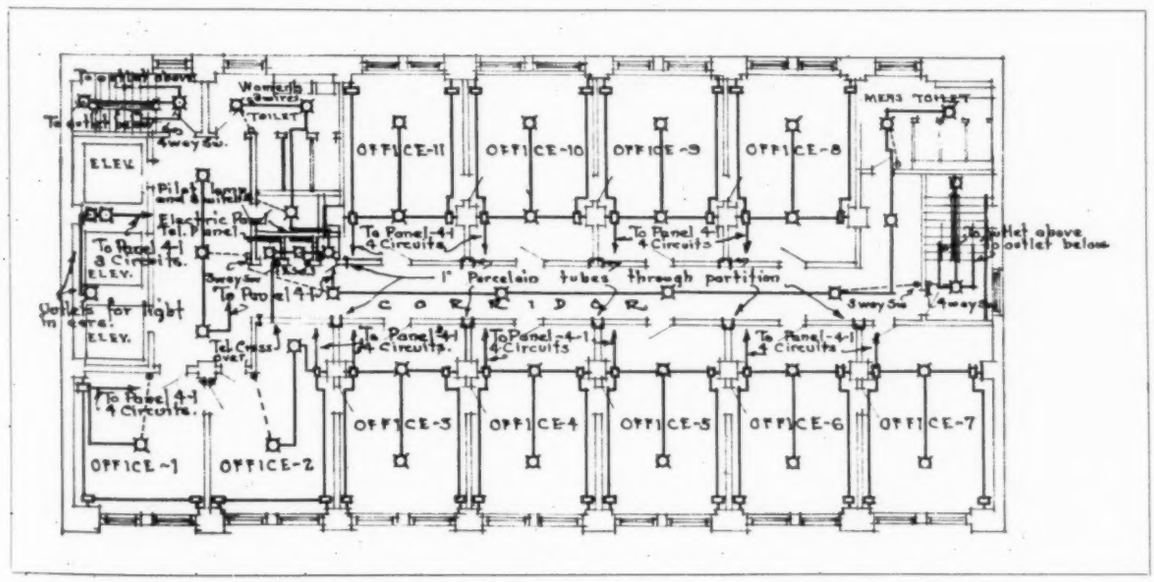
Assembly Hall. An assembly hall will require the lighting of the platform, by means of possibly one or more stage border reflectors, a footlight reflector, and a series of floor outlets and receptacles on the platform, and also flush receptacles at the front of the platform for the lighting of the music of an orchestra. Lighting of the hall will be from properly spaced ceiling outlets and from brackets on the side walls. The whole is controlled from a panelboard on the platform, and from a separate feeder from the switchboard.

Provision must be made for illuminated exit signs at all exits, as well as for emergency lighting for the aisles, etc., these circuits being fed from a separate panelboard in the lobby or convenient to the entrance of the hall. This panel should be controlled from a separate emergency feeder from the switchboard.

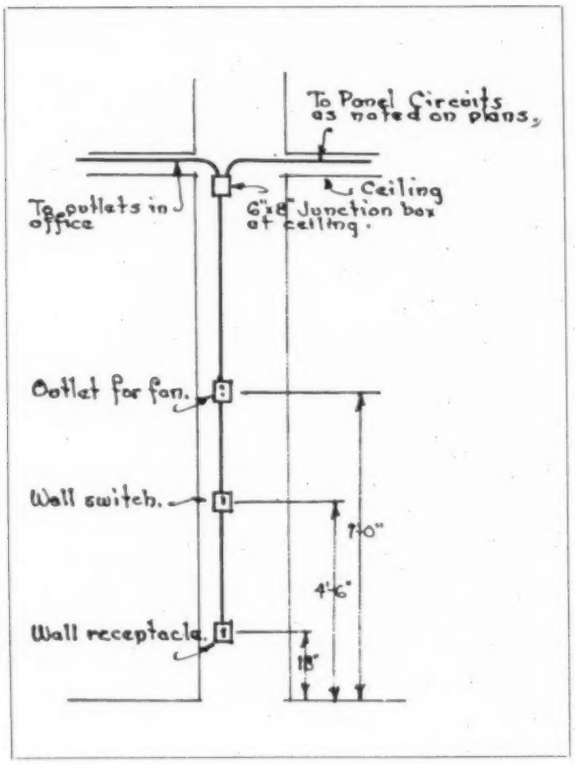
With the use of a projection booth, the lighting of the booth and adjacent rooms may be controlled from the lobby panelboard. A separate circuit, however, should be carried from the switchboard to the booth for the operation of the projector machines and lanterns, this equipment under the control of a separate panel in the booth. Provision should also be made for the control of the ceiling illumination of the hall from a remote control switch on the platform panelboard, with push-button control stations in the booth, and also for a return call bell system between the booth and the platform.

Cafeteria. A cafeteria will require lighting service, power service for the operation of kitchen motors, as well as electric heating circuits for the control of electric ranges, warming ovens, and miscellaneous electric cooking equipment. The lighting of the cafeteria may be under local switch control or controlled from a special cabinet in the cafeteria. Separate power and heating feeders should be run to the cafeteria from the switchboard, each terminating in a cutout panel in the kitchen, with tap circuits run to the respective kitchen motors and heating outlets. Power and heating feeders for the cafeteria should each be separately metered from the switchboard.

Wires and Cables. All considered, the successful operation of the wiring system is dependent upon the "insulation" of the system as a whole, and this applies not only to the insulation of joints and splices in outlets and junctions, panel and switchboards, etc., but also to the



Typical Wiring Layout for Small Office Building Divided into Small Offices



Typical Column Layout for an Office Building, Showing Dimensions

"grade of insulation on the wires." In the writer's experience, the cost of *high grade insulation* for all wires carrying secondary lighting or power voltage and for "code insulation" has been offset by the lower maintenance cost in operation.

It is further suggested that all wires and cables for use on primary circuits (2,300 volts and above) be insulated for not less than double the working voltage of the circuits on which they are to be used. Conduits and wires should not be installed in close proximity to steam pipes, or where subjected to high temperatures. Where it becomes necessary to run wires in trenches or elsewhere with steam piping, varnished cloth-insulated wires should be used rather than those of rubber. Cables insulated with varnished cloth may be generally used for feeder cables and mains; they are allowed a greater current-carrying capacity than rubber-insulated cables, and as a rule are cheaper to install.

Where feeder circuits are run under floors of sub-basements or in outside trenches and are subjected to moisture, the wires and cables must be sheathed with lead in addition to the insulation. Where the length of the branch circuits exceeds 80 feet, it is advisable to use nothing smaller than No. 12 wire.

Where vertical feeders or riser circuits are run to the panelboards in the wire closets and in elevator hoistways, etc., provision must be made for supporting the weights of the cables in a way other than from the terminal lugs of the panels and switches. The required clamping methods may be obtained from the code.

All wires used throughout the low tension system for the operation of clocks, bells and like equipment should be of No. 14 gauge as used for the lighting circuits, and should be installed with the same care as the wires of the lighting service. In view of the development of the circuits throughout an office building to meet the requirements of new tenants, as well as the tendency toward the use of high wattage equipment, the mains and feeders should be proportioned for not less than the full connected load of the building.

Outlet Boxes and Fittings. The exact types of the outlet boxes to be used for any installation must necessarily be dependent upon the building conditions at the outlets. In general, however, nothing less than the standard 4-inch galvanized conduit boxes should be considered for both fixture, switch and receptacle outlets. This also applies to both conduit and B X construction in second class buildings. Outlet boxes for use with low tension wiring should, in general, be of the same type as used with the lighting circuits, except where special boxes of cases are required for special equipment.

Local Switches and Receptacles. In general, flush switches will be used for the control of local circuits. The use of the tumbler or push-button switch is a matter of choice, either giving satisfactory service. Switch plates may be of brass, bakelite, or of composition, and either may be had in any standard finish. Where the circuit load is heavy, the use of a double-pole switch "connected single-pole," (with the two blades in multiple) will provide double capacity and reduce switch maintenance cost. It is good practice to set local switches not less than 58 inches above the floor in order that the switches will not interfere with the installation of a chair rail.

Local switches controlling the lighting in vaults may be set in the outside of the vault wall and adjacent to the entering door, such switches being made up in combination with a receptable, (for use with a portable lamp for the vault,) and with a pilot lamp that will glow when the vault lighting is in use.

Lighting outlets in closets may be controlled from switch combinations with pilot lamps, or door switches may be installed in the door jambs. Similar pilot lamps are of convenience in circuits controlling local electric heating equipment, these being wired to indicate when the circuit is in use, and also for use with small motors in ducts or remote from the point of the control.

Three-way and four-way switch combinations

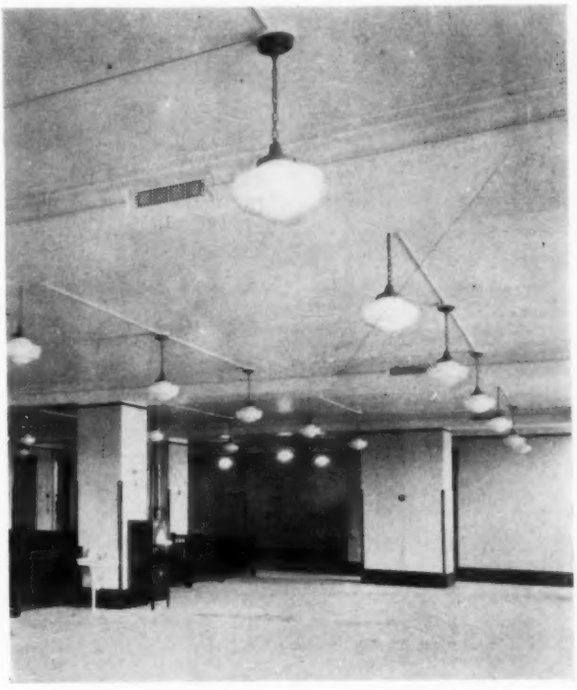
will be of convenience for control of corridor and stair lighting. Remote control switches may be used when it is required to control a circuit or motor from a distant point, the switch being located at the load with control wires running to and terminating in momentary-contact push-button stations, with a pilot lamp to indicate when the switch is closed. Approved safety switches must be used at all motors to master the circuit, these in addition to remote control switches if they are used.

Convenience receptacles, as a rule, should connect on circuits separate from the lighting outlets. Receptacles may be had in 10-, 20-, 30-, 50-, and 100-ampere capacity and in two- or three-pole type. Single circuits must be run to all receptacles of more than 10-ampere capacity, and also to 10-ampere receptacles where the anticipated load exceeds 300 watts. The carrying capacity of the wires connecting to high capacity receptables should be not less than the ampere capacity of the receptacle.

Lighting Fixtures. The type and design of the lighting fixtures for the building is largely a matter of choice. Lighting fixtures of special design will probably be required in the entrance lobby, for post standards, outside brackets, vestibules, and for special offices, etc., and they may be of the multiple arm, ceiling collar or pendant type, designed for direct, semi-indirect, or wholly indirect illumination.

The standard type of lighting fixture, in general use for office illumination, consists of a pendant or ceiling collar, (depending upon the height of the ceiling,) employing a single lamp of the required wattage, with a partial or wholly enclosing globe. Pendant fixtures may be of the rigid pendant type, the chain hanger type, or the "single link" type, which permits the pendant to always "hang plumb." In general, for good results, the lamp should hang from 8 feet, 6 inches to 10 feet above the floor. In corridors, toilets, etc., and where the ceiling height does not exceed 8 or 9 feet, some type of ceiling collar must be considered. In the design of the wiring layout ,the type of lighting fixture need be considered only in a general way, as with proper spacings and with ample wattage at the outlets, any desired type of lighting fixture may be used.

Power Circuits and Equipment. All motor circuits (other than for motors of fractional horse power) should be designed to operate from the separate power feeders from the power section of the distributing switchboard. These circuits are independent of the lighting service, even though the characteristics of the power and lighting services (as with a single-phase, or direct-current) are the same. Power and lighting services should be metered separately, to take advantage of the power rate usually offered by the companies.



Office Lighting Showing Development of Circuits from Central Outlets by Using Metal Moulding Conduit

Motors of fractional horse powers for desk fans and portable office equipment, etc., are standardized to operate at the lighting voltage of from 110 to 125 volts, and as a rule feed from receptacles and from the lighting circuits. Motors of fractional horse power for kitchen equipment, including dishwashers, polishers, grinders, food choppers, and refrigerator boxes, are standardized to operate at the lighting voltage for both direct or single-phase A.C. current, and as such motors are rarely of more than 1 horse power, they may connect from the lighting feeders or may operate from the power service and at the power voltage, with the motors balanced on the phases. The use of the standard single-phase motors on such equipment is to be preferred, as these motors are carried in stock, and can quickly be replaced in the event of breakdown.

All motor circuits should be run in conduits, terminating in fused safety switches at the motors, the circuit leading from the switches to the motor terminals. Direct current motors will require a controller or starting box connected between the switch and the motor. Alternating current motors of not exceeding 7½ horse power will not require controllers. Motors of more than 7½ horse power will require controllers or starters. This applies to both the constant and variable speed types. Where motors are stopped and started under remote control, or other than from

B&S Gage	Area in Circular Mils.	Capacity of Wires: Rubber Insulation Amperes	Varnished Cambric Amperes	Other Insulation Amperes	Conduit Sizes for: Size of Conduit, in Inches								
					1	2	3	4	5	6	7	8	9
18	1624	3		5									
16	2583	3		10									
14	4107	15	18	20	½	½	½	½	½	¾	¾	1	1
12	6530	20	20	25	½	½	½	¾	¾	1	1	1	1¼
10	10380	25	30	30	½	¾	¾	¾	1	1	1¼	1¼	1¼
8	16510	35	40	50	½	¾	¾	1	1	1¼	1¼	1¼	1¼
6	26250	50	60	70	½	1	1¼	1¼	1½	1½	2	2	2
5	33100	55	65	80	¾	1¼	1¼	1¼	1½	2	2	2	2
4	41740	70	85	90	¾	1¼	1¼	1½	2	2	2	2	2½
3	52630	80	95	100	¾	1¼	1¼	1½	2	2	2	2½	2½
2	66370	90	110	125	¾	1¼	1½	1½	2	2	2½	2½	2½
1	83690	100	120	150	¾	1½	1½	2	2	2½	2½	3	3
0	105500	125	150	200	1	1½	2	2	2½	2½	3	3	3
00	133100	150	180	225	1	2	2	2½	2½	3	3	3	3½
000	167800	175	210	275	1	2	2	2½	3	3	3	3½	3½
0000	211600	225	270	325	1¼	2	2½	2½	3	3	3½	3½	4
Circular Mils													
200000		200	240	300	1¼	2	2½	2½	3	3	3½	3½	4
250000					1¼	2½	2½	3	3	3½			
300000		275	330	400	1¼	2½	3	3	3½	3½			
400000		325	390	500	1¼	3	3	3½	4	4			
500000		400	480	600	1½	3	3	3½	4	4½			
600000		450	540	680	2	3	3½	4	4½	5			
700000		500	600	760	2	3½	3½	4½					
800000		550	660	840	2	3½	4	4½					
900000		600	720	920	2	3½	4	4½					
1000000		650	780	1000	2	4	4	5					
1100000		690	830	1080									
1200000		730	880	1150									
1250000					2½	4½	4½	6					
1300000		770	920	1220									
1400000		810	970	1290									
1500000		850	1020	1360	2½	4½	5	6					
1600000		890	1070	1430									
1700000		930	1120	1490									
1750000					3	5	5	6					
1800000		970	1160	1550									
1900000		1010	1210	1610									
2000000		1050	1260	1670	3	5	6						

the location of the motor, an overload and underload protective device must be provided at the motor.

The full load current as well as the permissible size of wires for motor circuits may be obtained from tables in the code; these should be followed in laying out motor wiring. Tables are also given in the code showing the current allowed for the different wire sizes, as well as the conduits allowed for the circuits.

Motors of large capacity should, in general, be connected on single circuits or feeders. Where motors are grouped, a single feeder may be run to a fused junction terminal with tap circuits taken from the cut-outs to the respective motors of the group.

Single-motor circuits should be proportioned for not less than 125 per cent of the full load-running current of the motor. Wires which will be required for motor circuits are:

Direct current	2	wires each same size
Single-phase A.C. current	2	" " " "
Three-phase A.C. current	3	" " " "
Two-phase four-wire A.C. current	4	" " " "
Two-phase three-wire A.C. current	2	" " " "

The neutral or third wire to be 50 per cent larger than either outside wire.

To be concluded in the November issue.

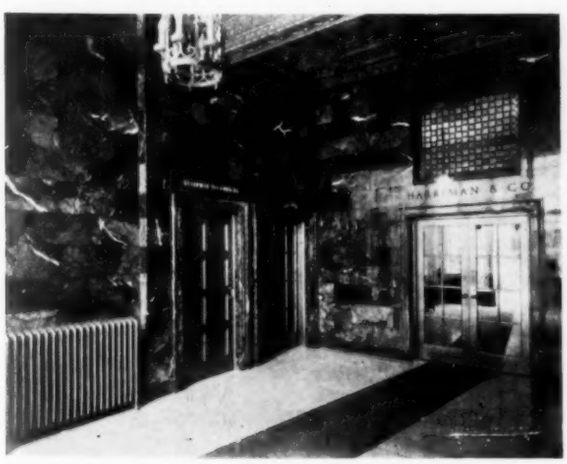
MODERN TENDENCIES IN THE USE OF MARBLE

BY

CLIFFORD WAYNE SPENCER

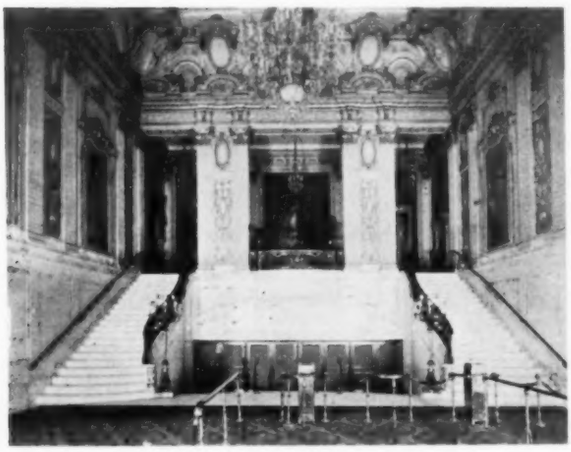
MARBLE in various forms and uses has furnished one of the records of the character of the various stages through which civilization has passed. The marble structures of ancient Greece are a true indication of the severe simplicity of Greek taste, while the riotous luxury of the Roman Empire was expressed in terms of richly colored marbles and brilliant mosaics. And so it has progressed through various color cycles to the present time. Within the period of our own history, very marked tendencies along these lines can be discerned. Beginning with the pure white of the Colonial and Greek Revival periods, popular taste gradually developed in favor of more richly colored decorations, and the result was the "Victorian" style which was characterized by the use of richly colored red and black marbles in connection with highly ornamental oak or mahogany woodwork. Again the wave of color subsided, and for the past two or three decades we have had cool white marble with more recently a decided tendency toward the use of the buff monotones, such as Botticino and Tavernelle. In any town of considerable size, bank interiors and other buildings can be found whose interior treatment is based entirely on the use of buff marble. In fact, buff marble has come to be considered the "bread and butter" of the marble industry, like sugar in a grocery store. The marble yards of the country are stocked with this type of marble, and it can be supplied in large quantities.

But the world moves on, and the pendulum swings rapidly in the opposite direction. There is little doubt that we are now entering upon a new color era, which, stimulated by new discoveries and scientific research, bids fair to go beyond anything we have yet known. Always the builder has loved to work in marble. The effects to be gained by its use are unlimited in number, and its lasting qualities are such that his work will endure. Moreover, no material lends itself in quite the same way to the expression of beauty in color. Its colors are natural, and therefore have unlimited possibilities from the standpoint of harmony. Color is now being used where once it was not even considered, and especially is this true of the modern home. Formerly, little marble was used in domestic architecture except in the most pretentious homes of the very rich. Now, however, it has a very definite place, and lends color to many bathrooms and is being used in mantels, radiator coverings, as well as for many exterior uses. These uses of marble are being very definitely recognized by a new policy which has been adopted by the marble industry as a whole. Marble was formerly sold to dealers by the great producers and distributors in block form only, so that if an architect or his client particularly desired a certain kind of marble for a mantel or lavatory slab, he might find that dealers in that locality did not happen to have a block of that particular variety on hand and could not afford to buy one for such a small order, so that a less desirable variety would have to be substituted or the use of marble abandoned altogether. Now, however, the producers offer to sell marble of any variety in lots of one slab or more, so that the architect can now have much greater freedom in



Entrance to Office Building in Dark, Richly Colored Marbles

Golden Veined Ashlar Walls With Red Levanto Trim



In Elaborately Decorated Interiors, Plain White Marble May Be Used Effectively

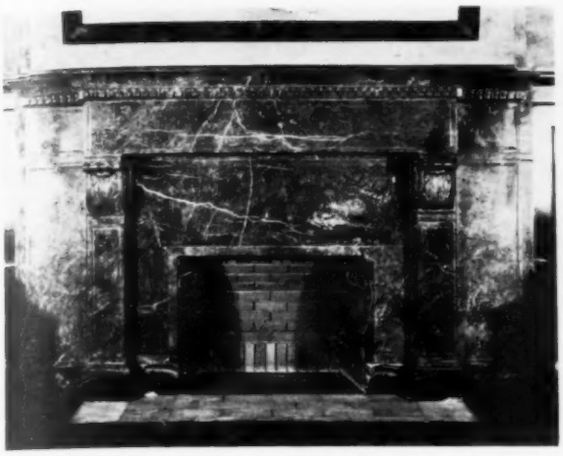
The Carpet-like Pattern in Marbles Relieves the Monotony of Wide Floor Areas

making his choice of marbles for such purposes.

In choosing marble for use in a prospective building, there are many points to be considered, and experienced marble men should be consulted in all cases. The choice of marble requires some thought, there being about seven hundred different varieties available in this country at the present time. This does not mean that the choice can be made indiscriminately. For instance, an architect may choose a beautiful marble and base his whole scheme of decoration on it only to find that it cannot be supplied in quantities sufficient for his needs. He may wish to use monolithic columns of such sizes that only a very limited list of marbles can be had with sufficient length to serve the purpose. Again he may find that the physical properties of his chosen variety are such that it is unsuitable for his particular project. All these details should be investigated.

The supply of marble depends not only on the existence of the deposit in large quantities, but on its accessibility and the methods used in quarrying it. There are vast quantities of beautiful stone hidden away in the hills which are so inaccessible that only a very limited supply of them is to be had. The mountains of Colorado have vast deposits which are scarcely touched because of the great difficulty in bringing the marble to market. Some quarries in that state are worked, and we have the beautiful Colorado Yule which is available for fairly large buildings, but which is marketed with great difficulty. Another illustration of this is found in Spain, where there are deposits of the richest marbles, which were so greatly desired by the ancients that they were transported in great quantities to the Italian cities and even to Greece and more distant countries. The retrogression which has taken place in Spain has caused such great confusion in the transportation system that these valuable marbles are quarried only in very limited quantities, and then only for local use. The length of the working season is another factor governing supply. If a quarry can be worked for only three of four months of the year, the supply will naturally be limited. This is the case in many of the quarries located in the Pyrenees and the Alps in Europe, and in Colorado and Alaska and the northern sections of North America. This handicap has been overcome in many cases in this country by using modern quarrying methods, and this is especially true of the Vermont district, where most of the quarries are in the form of tunnels and can be worked throughout the year. The southern districts, such as Georgia, Tennessee, Missouri and Alabama, are of course, not subject to this condition, and quarries there are worked in the form of open pits. Modern quarrying methods are doing much to insure a steady supply of blocks. In this country practically all operations are carried on with mechanically operated channeling and drilling machines, so that a constant supply of blocks can be had with very little waste. In Europe, however, the general procedure has been to blow off the side of a mountain or to split off blocks by means of wedges, and to salvage as much of the debris as possible. There has also been use of wasteful methods in this country, foremost among which are those causing the ruining of the deposits of white marble in New York state, and of the black marble beds in Virginia by blasting. The loss of the Virginia black marble is to be particularly regretted, as it is said to be the most beautiful and uniform black marble found anywhere in the world. These quarries are now being worked for terrazzo chips, and it is possible that solid marble will be reached and that this valuable variety will be made available once more.

The sizes of blocks depend on the formation



Native Utah Marble is Used in this Mantel in the Church Administration Building, Salt Lake City

Domestic Marbles Are Unsurpassed for Giving an Effect of Cleanliness to Shop Interiors

of the strata as well as on the facilities for getting out and transporting the blocks. Many varieties can be had in sound blocks of 5 or 6 feet only, while others are limited in size only by the machinery used to raise them from the quarry. A block of white marble, weighing 63 tons and being 14 feet square and 3 feet thick, was especially quarried for the basin of the Scott Memorial Fountain in Detroit, and monolithic columns can be had as large as 32 feet long by 4 feet in diameter. It is always best to ascertain what sizes are available before planning to use monolithic blocks of large sizes.

Another matter to be carefully considered in choosing marble, is that of the suitability of its physical properties to the conditions to which it will be subjected. Marble is not wholly a scientific classification but a trade name, applied to a certain class of limestone possessing peculiar characteristics. In general, marble is more dense and is said to be "metamorphosed" or "recrystallized" limestone. It is more compact and is generally distinguished from limestone by its ability to take a polish. The line of demarcation between limestone and marble is rather vague, and it is sometimes difficult to tell in just which class to place a stone. In general, marble is divided into three classes according to chemical composition. The calcites are almost pure lime carbonate, while Dolomite marble carries a high percentage of magnesium carbonate, and the serpentine marbles have abundant silicates crystallized with the carbonates. The tensile strength of marble is very great, which fact not only adds greatly to its structural value, but makes it especially adaptable to delicate sculptural ornamentation. The crushing resistance of marble ranges from 11,000 pounds to the square inch to 22,000 pounds per square inch, depending on the variety. Its resistance to heat is especially important in case of fire, and marble is well up in the list of stones in this respect. Under carefully conducted tests, it was found that marble may be subjected to a heat of 12,000° Fahr. without physical change. The freezing of liquids absorbed by stone is very likely to cause disintegration of its structure, but so small is the quantity of moisture that can be taken up by marble (from .06 to .09 by weight) that there is no great danger from this source. This quality of non-absorption is also of great advantage in resisting stains from oils, dyes and other liquids. The quality of hardness is very important, especially where the material is to be subject to constant wear, as in floors and stair treads. Everyone knows how hollows will be worn in stone floors and steps by the passing of countless feet over a long period of time.

Special care should be taken in using stones of different wear resistance in the same floor, as the floor is likely to become hilly or uneven through wear. An example of this is found in the Union Station at Washington, where a very hard red Champlain marble was used in connection with a softer white marble to gain decorative effect, and the heavy traffic has worn away the white marble leaving the red projecting quite noticeably. The United States Bureau of Standards is making tests at the present time to determine the wearing qualities of floors and the possible remedies, if any. An apparatus has been designed, and tests with this are being compared with a series of measurements of similar materials under service conditions. A paper showing the results of these tests is now ready for publication and should be of great interest. It contains the results of abrasion tests on about 90 materials, including marble, slate, limestone, and sandstone.

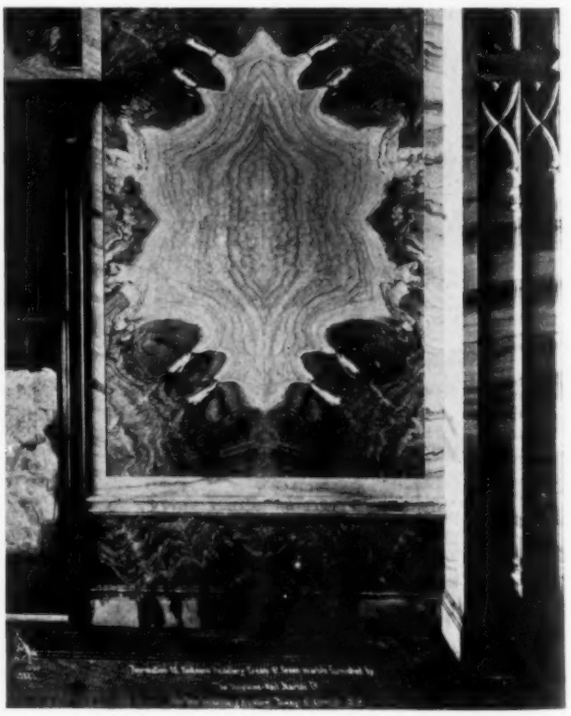
Perhaps the most important consideration in choosing marble to withstand special conditions is that of soundness. Many of the varieties most

highly prized for their rich color and pattern have, by their very nature, natural fissures and depressions. These defects are successfully remedied by the use of wax and by "sticking" the marble together, and in some extreme cases by cementing it to a "liner" of heavier marble or some other sound stone. It is said that in ancient times it was the custom to specify that marble should be *"sine cera,"* without wax,—and that it was from this custom that our English word "sincere" was evolved. One should not get the impression, however, that marble that is waxed or "stuck" is not an honest product or that its value or durability is lessened thereby. Whatever may have been the practice in times past, the marble industry, in common with the rest of modern business, has adopted the principle that honesty and frankness are the best policy, and if an architect or his client will consult a reputable marble man as to the soundness of a given brand of marble, the facts will not be misrepresented, no matter how much of that particular variety the dealer has for sale. Of course, there are some instances where the use of a highly waxed marble should be avoided. Wax should never be used on exterior marble. It should not be used where it will be subjected to an unusual amount of heat, such as around radiators or as mantel facings for fireplaces. While the color and veining of marble can be matched perfectly with wax, the wax has not the same wearing qualities as marble, and in time a slight change of color or shade may occur in the wax, due to impurities absorbed from the air. For this reason it is sometimes not advisable to use wax in buff monotones or white marble, as the wax which originally matched the color of the marble may change slightly in color and betray itself. An example of this is seen in the Botticino of the Grand Central Building, New York, where the wax veins are quite conspicuous in some places. This as often enhances the beauty as not. The National Association of Marble Dealers has classified the various marbles according to their soundness into these four classes:

Group A.—Sound marbles and stones, which require no sticking, waxing, or filling, and which possess characteristically uniform and favorable working qualities.

Alabama
Alaska Tokeen
Blue Vermont
Caen Stone
Carthage
Chassignelle
Clarendon
Colorado White
Georgia Cherokee
Georgia Creole
Gravina
Italian English Vein
Italian White
Kasota Pink
Lee
Logan Missouri Gray
Mankato Pink
Napoleon Gray
Pentilicon
Red Ark Fossil
Regina
Tennessee
Vermont French Gray
Vermont Lepanto
Vermont Pearl Gray
Vermont Verdoso
Vermont White Grades
Wellington Cream

A Large Variety of Colored and Plain Marbles in The Elks' Memorial, Chicago



Patterned Panels May be Formed of Burled Marble Slabs

Group B.—Marbles and stones similar in character to those of the preceding group, but having somewhat less favorable working qualities; occasional natural faults; limited amount of waxing and sticking necessary.

Alta Vein
Batesville
Belgian Black
Bianco Statuary
Blanco P
Breche Blanc
Champlain Black
Champville
Colorado Travertine
Eastman Cipollino (light)
Eastman Cipollino (dark)
Eastman Cream (light)
Eastman Cream Statuary
Eastman Cream Green (veined)
Fossgraynel
Glens Falls Black
Italian Statuary Vein
Kasota Yellow
Mankato Yellow
Middlebury Italian
Regal Blue
Travertine
Vermont Champlain Jasper
Vermont Champlain Lyonais
Vermont Champlain Oriental
Vermont Pavonazzo
Vermont Royal Antique
Vermont Swanton Black
York Fossil

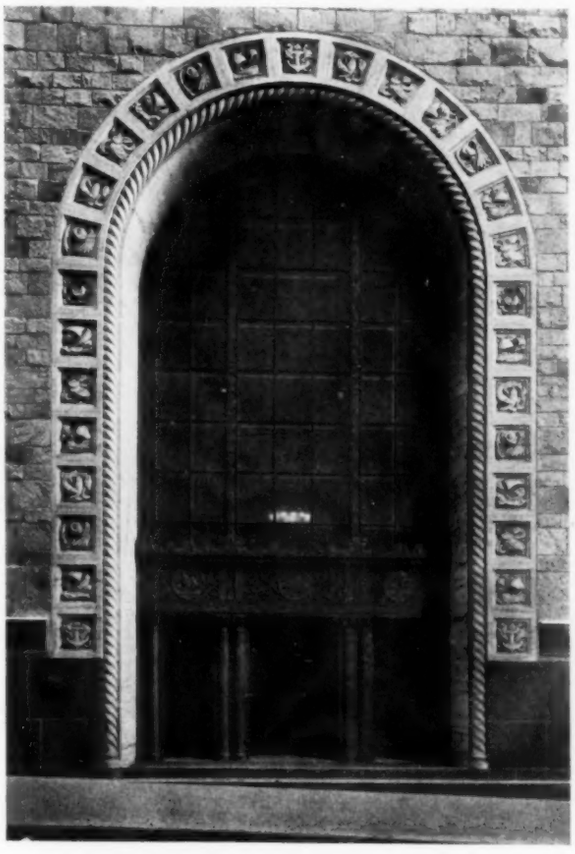
Group C.—Marbles of uncertain variation in working qualities; geological flaws; voids, veins and lines of separation common; standard shop practice is to atone for Nature's shortcomings by sticking, waxing and filling; "liners" and other forms of reinforcement freely employed.

Alabama
Fancy Grades
Basseville
Blue Belge
Bois Jourdan
Botticino
Breche Opale
Breche Pavonazzo
Breche Stazzema
Breche Violette
Brecia Fiorito
Campan Melange
Cenere
Eastman Heidelberg
Emerald Curley Green
Escalete
Famosa
Furst Gray
Hauteville
Italian Pavonazzo
Jaune Benou
Juraville
Rosato
St. Genevieve
Skyros "A"
Skyros No. 12
Skyros No. 14
Tavernelle Clair
Tavernelle Fleury
Tavernelle Rose
Tinos
Tranivelle
Verdello
Vermont Verde Antique
Verd d'Estour
Verona Red
Verona Yellow
Wallen Gray
Westfield Green

Group D.—Marbles and stones similar to those of the preceding group and subject to the same methods of finishing and manufacture, but embracing those materials which contain a larger proportion of natural faults and a maximum variation in working qualities, etc.; this group includes many of the highly colored marbles prized for their decorative qualities.

Alps Green
Biegenelle
Black and Gold
Breche Oriental
Breche Rose
Brocatelle Violette
Byzantine
Campan Rouge Griotte
Cardiff Green
Cipollino Greek
Cipollino Swiss
Eschaillon
Fleur de Peche
Florido Rose
Forest Green
Genoa Green
Grand Antique
Griotte
Jasos Arobico
Juane De Brignolis
Languedoc
Levanto
Maurin
Monte Aurato
Moreisque
Nebo Golden Travis
Numidian Pink
Numidian Red
Numidian Yellow
Onyx
Portoro Rose
Rosso Aligante
Rosso Antico
Rouge de Rance
Rouge Etrusque
Rouge Royal
Royal Jersey Green
Royal Rose
St. Baume
Siena Gray
Siena Yellow
Sylvan Green
Verde
Vert Antico
Vert Campan
Violet de Brignolis

Another point on which a careful architect should be well informed is in regard to the care that is necessary in maintaining marble in its original state. It might be felt by some that when the building is finished the architect has no further concern. However, if materials which he has selected grow dingy and do not weather well, he will be blamed by many for not having made a wise choice. Then, too, if the owner finds on completion of the work that there is an unusual amount of maintenance cost which he had not expected, he is likely to hold the architect morally responsible. The owner should be warned in advance as to exactly what will be necessary to keep the marble work in good condition. With regard to unpolished exterior marble, it is true of marble as of other stones that "the mellowing influence of time is a great beautifier of architectural work." In the process of weathering, the cold and dazzling whiteness of freshly cut stone takes on an atmosphere of antiquity and warmth that is greatly to be desired. Buildings may be robbed of a distinct part of their charm and dignity through the laborious process of cleaning. Be sure, therefore, that the building actually needs cleaning and will be improved thereby. Sandblast cleaning should never be resorted to, as it removes



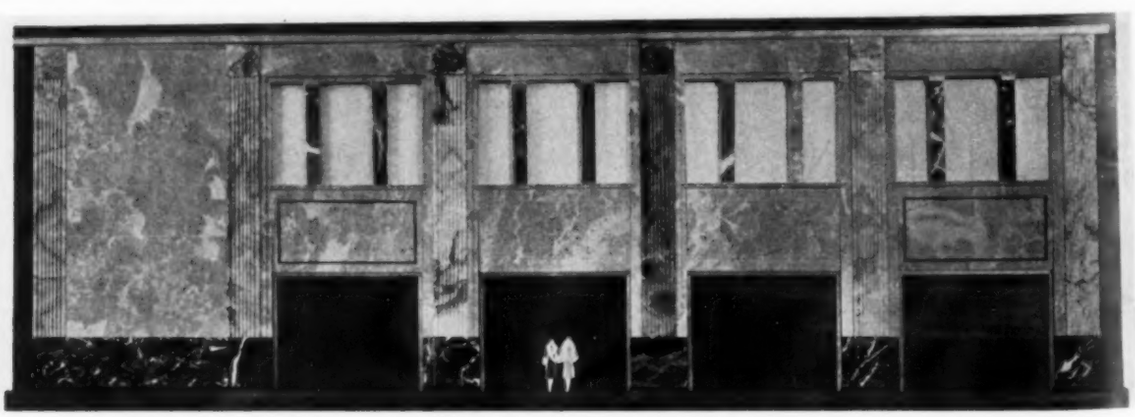
A Carved Doorway of Gray Missouri Marble

Colorado Marble is Especially Suitable for Exterior Work

White Vermont Marble is Used Extensively for Public Buildings

the surface and thus lays the stone open to more easily becoming soiled and stained. Also, the sandblast treatment has a tendency to wear down the sharp edges and arrises of the tooling and carving, sometimes to the extent of obliterating them altogether. If the building must be cleaned, the best method is to scrub it with a good cleaning solution and water, using plenty of "elbow grease." Where highly polished marble is used externally, considerable care is required. There is probably only one marble (Westfield Green) that will hold polish indefinitely when exposed to the elements. In all other cases, marble soon becomes dull and dingy, and there is nothing which tends more to give the front of a building a dilapidated appearance than the presence of marble that has once been polished but has lost its luster. Such marble should be gone over regularly, at least once every four weeks with a mixture of beeswax and turpentine and then polished till the original luster returns. In the case of interior polished marble, this is not necessary, but it should be washed regularly to remove the film of grease and dirt that tends to form on the surface and to dim the polish. Of course, the length of time that a marble will hold its polish varies greatly according to the variety. In general, the harder marbles are harder to polish, and for that very reason are likely to retain their polish much longer. There are many preparations for removing all sorts of stains and discolorations from marble, and these are fully described in a booklet called "Maintenance of Interior Marble," compiled by the National Bureau of Standards and published by the National Association of Marble Dealers, 648 Rockefeller Building, Cleveland.

The many conditions under which marble is manufactured in various parts of the country and the varying costs of transportation and setting make it impossible to give any very definite information as to the cost of marble. This depends on the accessibility and extent of the supply. The difficulty by which it is manufactured and transported to the building site is also an important factor. A price for marble quoted in one locality may be utterly misleading



Scale Models May be Made of Actual Marble Samples

when applied to an estimate for work to be done in another locality. In general, however, marbles can be said to fall into comparative price classes. The domestic marbles of comparatively slight coloring are in the low price class, along with some grades of white Italian marble. The buff monotones are in a slightly higher class and include Botticino, Buffneato, Montenelle, Beige Nelle, and Tavernelle. The next class includes buffs carrying some color and bringing a higher price, such as Hauteville, Florido, St. Baume and Jaune Lavatine. The next price class includes the Breccias (Roman, Oriental, Rose and Violette), and other colored marbles. A still more expensive group includes both domestic and foreign varieties of reds and dark greens and other highly colored marbles. Marble for exterior use is somewhat higher in price than most of the other materials used for this purpose, and its general use fluctuates with the prosperity of the country. Its great beauty coupled with its lasting qualities and the low cost of upkeep causes it to be chosen in many cases where securing a low initial cost is not important. Many buildings are built of a very beautiful random ashlar which is made of what is practically waste material from the marble mills and can be used at a cost only slightly higher than that of brick.

Exterior marble is most often specified in "sand finish," as this brings out to the greatest degree the natural veining of the stone. It is put on by rubbing the sawed blocks with coarse sea sand. Where a rougher finish is desired, tooling is often specified. The work is done by hand or by a special tool used in a planer. It leaves a slightly corrugated surface, the lines being continuous and evenly spaced. When the lines are irregular and finer than tooled finish, it is known as "axed finish." Rock-face ashlar is also very beautiful for exterior marble work, the face of the block being chipped off after the pieces are sawed, leaving a natural stone finish.

Commercially speaking, marble is any stone that is of less hardness than granite; that is sufficiently close-grained to take and retain a polished face; and that can be obtained in quantities sufficient for commercial use. Many stones that are not strictly marble are considered by the trade as such and are handled by marble dealers and included in lists of marble. Among these is travertine, a very important building stone, widely used for interior ashlar and trim and very suitable for floors on account of its hardness and non-slipping qualities. This is a limestone formed by the action of water in limestone caves. Another stone not properly marble but often considered as such, is onyx, which is composed largely of lime and is formed by the precipitated lime from the water of hot springs. The various kinds of marble are distinguished from one another by trade names adopted in many cases arbitrarily, but usually being descriptive of the coloring or formation of the veining. Thus the term "Breche Violette" is both descriptive of the broken triangular markings and the rich violet coloring. Cipollino marble, which comes from Greece, and which has been used since the days of the Roman Empire, is so named because of the fact that its layers resemble those of an onion. Other varieties are named from the regions or towns in which they are quarried, and many are named from important buildings in which they were first used, such as "Steinway Green" and "Cunard Pink." One variety, which bears the high sounding name "Loredo Chiaro," derives its first name from a combination of the first two letters of the first name and the first three of the last name of the architect who was instrumental in introducing it in this country,—Eddie Lord. Another case of the arbitrary adoption of a name was when some particularly fine gray and gold marble was shown a German architect and he exclaimed in delight, "*famos*," so this variety has since been called "Famosa."

These trade names do not refer exclusively to the product of any single producer but are adopted merely for the purpose of distinguishing a particular variety from countless others. The distribution of marble deposits is very wide. Scarcely any section of the country is without some such deposit, although most of them are not worked for one reason or another. Quarrying ventures are regarded with a great deal of uncertainty and are considered a highly speculative investment. It would be impossible in the space of this article to discuss all the different deposits and varieties produced in the country. However, some of the more important, from a commercial point of view, can be treated briefly.

The Vermont region, which has been more thoroughly exploited than any other marble-producing district, furnishes a wide variety of high quality marbles for both exterior and interior uses. The West Rutland deposit alone furnishes over 15 varieties ranging from almost pure white statuary marble to dark greens, such as Verdoso and Olivo. The quarries along the Otter Creek Valley furnish good varieties, most of which are white or pearly white with blue or gray markings, among which Pittsford Italian and Florence are important commercial varieties. The Vermont Verde Antique is very well known and is quarried in the central region. Its extreme hardness makes special machinery necessary for quarrying and manufacturing this variety of serpentinous marble. The Champlain reds are very rich in coloring and include Jasper, Oriental, Olive, Lyonais and Royal Red. The Georgia

deposits of crystalline marble are particularly adaptable for statuary work and exterior building, two notable examples of its use being in the statue of "Civic Virtue," New York, carved from a single 55-ton block 14 feet x 8 feet x 6 feet, and the McKinley Memorial, at Niles, O. The main deposit of Georgia marble is said to be a solid block four miles long, three-eighths of a mile wide and between 185 feet (known depth) to a half mile (estimated possible depth) deep. It ranges from light, slightly clouded gray to dark gray. There are also a very vivid pink variety and a good quality, even veined Verde Antique available in quantities to supply architects' needs. The Tennessee region is also an important producer of marble, most varieties being of the fossil-bearing class. It is used most extensively for interior work, such as walls, floors, stairways and toilet room work. There are three distinct classes designated by various trade names. The grays and pinks usually have a characteristic wavy black line, called "crowfoot" veining, running through them at intervals. The dark brown varieties are known as Dark Cedar or Dark Chocolate and are of a very rich uniform appearance. They have been produced in large quantities and have been very widely used in public buildings throughout the country. Missouri is also an important marble district, most varieties being of a warm uniform gray with or without black pencil-like veining. A variety that is particularly desirable is the Golden Vein, which has a ground mass of silver gray with occasional golden markings. This compares very favorably with the imported Famosa. The Missouri marbles are especially adapted to interior work and have been widely used for floors and walls in washrooms as well as public lobbies, banking rooms and corridors.

The only marble quarried in important quantities in Colorado is the Colorado Yule, which is found near Marble, Colo. This is an extremely beautiful white-to-gray material, suitable for exterior purposes. The main structure of the Lincoln Memorial, at Washington, is built of this beautiful stone, as are also many other fine monumental buildings throughout the country. Colorado travertine is also available in large quantities and compares very favorably with the foreign variety, being somewhat warmer in coloring than Roman travertine. The Alabama varieties are suitable for both exterior and interior use and are very striking in their vivid, dark, contrasting veining; the best known variety is Alabama Madre Vein. From Alaska comes a remarkably beautiful interior marble of light, pearly gray background, the Tokeen variety having light gray, clouded veining, and the Gravina, very definite black markings. Both are extremely beautiful and are widely used, especially on the Pacific coast. Maryland has important marble deposits, and much marble which was used in the national capitol came from this state. Now, however, most of these quarries are inactive. One of these quarries has recently been reopened and is producing a beautiful soft Verde Antique called Cardiff Green. Another deposit of valuable Verde Antique here was ruined by destructive blasting, and what might have been valuable marble is now being used as railroad ballast. Among the Dolomitic marbles, are those of Lee, Mass., used largely for structural purposes. Another important variety produced in Massachusetts is Westfield Green, famous for its ability to retain its polish when exposed to the elements. The white Dolomite marble of South Dover, N. Y., is an important building stone which is widely used, a notable example of its use being for the Savoy-Plaza Hotel, New York.

France, Italy and Belgium are the principal sources of marble in Europe, although other countries are rich in marble deposits. Italy is perhaps best known for its marbles, and among others the white statuary marble of Carrara is well known for sculptural purposes. Among the highly colored varieties from this country are Black and Gold, Alps Green, the various Breccias, Siena marbles of varying yellow tints, Botticino which has had such general use recently, Pavonazzo, Tavernelle, and a long list of other richly veined marbles. The marbles of France are equally as varied and as richly colored. Among the better known are Escalette, Grand Antique, Hauteville, and the various Breche varieties. From Belgium comes Belgian Black, the standard black marble in use today. There are also Blue Belge, Rouge de Rance, and Rouge Fleuri. The Famosas from Germany are also well known as are several other varieties. Other sections of Europe also are rich in marble, and American marblemen are going about prospecting for new and more beautiful marbles to meet the demand that is sure to develop as we learn to use more and more the beautiful colors nature has given us. Marble must be seen to be appreciated, and a visit to some of the marble sample rooms, which are located in all large cities, is best when there is a choice of marble to be made for architectural use.

THE SUPERVISION OF CONSTRUCTION OPERATIONS

BY

WILFRED W. BEACH

CHAPTER 9. CONCRETE WORK, CONTINUED

THE specification clause on measuring reads: "MEASURING. A systematic method shall be employed for the measurement of all materials, including water. Measurement by shovels or barrows (other than approved measuring barrows) is prohibited. Measurement of aggregates shall be by loose volume, the unit being a 94-pound bag of cement, assumed to be equivalent to 1 cubic foot."

There can be no misunderstanding about measurements of concrete ingredients, but there can be much variation in the accuracy by which this measuring is performed. Contractors, doing their own work, may easily train men to use shovel measurement with fair accuracy and with small economy on minor work, but the method is forbidden on all operations supervised by architects or engineers. Before mixing is started, the barrows should be measured by filling cement sacks with aggregate, then emptying them into the barrows, thus judging the degree of fullness taken up by the required amount; but, inasmuch as a cement sack will contain only about ⅞ cubic foot of sand and slightly less of the coarse aggregate, due allowance should be made for this variation. The barrow capacity can also be measured by dumping cement into it up to the amount of sand specified; or the contractor can have a box made of 1- or 2-cubic foot capacity, to use for a measuring device. This latter is convenient for hand mixing where a barrow is unnecessary. Having determined the barrow measurement, the inspector must see that it is closely adhered to, that all barrows used are identical, and that, where the mix is varied for plain and reinforced work, the change is made in feeding the mixer.

(3). *Cement Must be Fresh, Up to Standard, and Used in Correct Ratio.* The character and quality of Portland cement are matters of laboratory determination. The superintendent of the schoolhouse construction sent in samples for test as soon as he could get them from the first car, and from each successive car thereafter. None was permitted to be used until reports upon it were received. If these had been unsatisfactory, there would have been no alternative but to reject the entire car, if the samples were properly representative of the shipment, and a new source of supply would have been necessary. As was set forth in Chapter 5, it is extremely unlikely that any but acceptable cement will be sent to a job where it is supposed to be tested. Manufacturers do their own testing and know their products. In certain localities, it is customary to specify that each bag of cement shall bear a test tag, and this evidence of quality is supplied by the manufacturers at an additional cost of 10 cents a bag. On small work, this is the best procedure but, on large work, such increase of nearly 20 per cent to the cost of the cement is too heavy a tax. Proper storage and care of cement after delivery will guarantee its suitable condition at the time of use. But if any is overtaken by accident and suffers water damage, it should be discarded and thrown aside at once.

(4). *All Ingredients Shall be Properly Mixed.* On this subject, the specifications say:

"MIXING CONCRETE. All concrete shall be mixed in a rotating batch mixer, except that, under certain conditions, the superintendent may permit small batches to be mixed by hand. Under either method, the materials shall be thoroughly mixed dry, then sufficient water added to produce concrete with required moisture content. A competent foreman shall be in constant attendance at the mixer to see to the correct proportioning and mixing of each batch produced. Mixing drums shall operate at a uniform speed of 200 feet per minute and for a minimum of 1½ minutes after water has been added. Volume of materials per batch shall not exceed the maker's rated capacity of mixer. Machine and hoppers shall be thoroughly cleaned before being allowed to stand idle. For hand mixing, the cement and sand shall first be mixed dry by being turned over three times, then the coarse aggregates added and again turned three times while water is being added to produce the required consistency."

As to the required consistency, this is determined by test, specified thus:

"SLUMP TEST. All concrete mixtures shall be subject to a slump test by the Contractor, once or twice a day during pouring, as requested by the Superintendent and under his direction. For such test, the Contractor shall provide a conical form of No. 20 gauge galvanized iron; also a ⅝-inch pointed metal rod, 21 inches long. The form shall be 8 inches in diameter at bottom, 4 inches at top and 12 inches high. The percentage of water in concrete shall not be in excess of that required to produce a maximum slump of 4 inches for mass concrete and base of floors on earth, and a maximum of 7 inches for reinforced slab, beam and column work."

Greater refinement in slump testing is often met with in specifications,[1] but refinements are not characteristic of such testing, which is merely a rough method of ascertaining in the field whether the concrete is being turned out as moist as desired and whether it reaches the work in that condition. "Inasmuch as the amount of water required will depend upon the dampness of the ingredients, the richness of the mix and the percentage of fine aggregate, it is not expedient to specify any exact quantity of water, and hence the burden is on the superintendent to see that the correct amount is used. Its three-fold purpose should be remembered, viz:

(1) To carry cement in suspension and hold it in contact with the surface it is to bind.

(2) To produce the proper fluidity of mass for best manipulation.

(3) To combine with the cement to bring about crystallization and adhesion.

"The success of concrete work depends upon how well these details have been carried out, to the end that maximum density shall have been achieved."[2]

The first of these conditions results from thorough mixing; the second is demonstrated by the slump test; and the third implies that the water, once mixed with the cement, shall be allowed the proper period of repose and none be permitted to be withdrawn by evaporation, suction or other means. Whereas the specifications permit the superintendent to demand two slump tests a day of the contractor, these are seldom needed except where immense quantities of concrete are being produced. An experienced inspector has learned to judge the output of the mixer by its color and consistency, and hence will not demand frequent tests. While work is under way, other tests[3] may be in order and should receive the attention of the superintendent. Inasmuch as testing during construction can serve no purpose other than to influence greater care in the making of concrete, such tests are not often used, final tests of actual slab construction serving the same end.

There are various methods in use for the regulation of water supply in the mixer, but one finds the "rule of thumb" method most in vogue. With an experienced man in charge, there is no particular objection to this,—but such a man is not always in charge, and hence mechanical regulation is preferable. For large operations, there are on the market mixing devices in which the water supply is regulated by the degree of moisture content in the aggregates as determined by their weights.

Not only is the density of the concrete to be considered in connection with the water ratio, but also the ultimate resistance of the finished product to the forces of disintegration. It is fairly well established that complete crystallization of all the cement in a mass is a very slow process, and hence the importance of keeping concrete moist during curing, as will be brought out more fully later. Concrete improperly hydrated will absorb free moisture to an extent that will cause it to swell. If it freezes in that condition, the swelling is dangerously increased. If it then thaws and later dries out, the mass contracts. As this process is repeated, hair cracks appear, absorbency becomes greater,—and disintegration may set in. But to such a degree as concrete is properly hydrated, to just that degree does it become impermeable to free water and less subject to expansion and contraction and to effects from alternate freezing and thawing.[4]

(5-a) *Concrete Mix to be Deposited Promptly Without Separation of Ingredients.* Concrete mixes are delivered to places of deposit by direct spouting from the mixer, or from a tower and spouting adjoining the mixer, or by wheeled vehicles (barrows, buggies or trucks), or by combinations of these devices. The essential is that the conveyance used shall carry the concrete to its final resting place in time to permit adequate tamping or agitating within the 30-minute limit specified:—

"PLACING. Concrete shall be conveyed to point of delivery in watertight carriers and deposited as nearly as possible in final position immediately after mixing. Re-tempering or unnecessary re-working of concrete will not be permitted, and any concrete placed or disturbed after 30 minutes from the time water has been added to the cement will be rejected and must be removed from the premises. Pouring shall be continuous from working joint to working joint. Each column shall be poured in a continuous operation. Overtime labor shall be provided for these purposes, without extra charge, where such continuity cannot be otherwise secured. If spouting is used, the plant shall be of such size (with spouting at such incline) as to

[1] The Portland Cement Association, in "Design and Control of Concrete Mixtures," publishes this table of:

Recommended Slumps for Concrete

Type of Structure	Slump in inches Minimum	Maximum
Massive sections, pavements and floors laid on the ground	1	4
Heavy walls, slabs, beams	3	7
Th'n walls, columns, etc.	4	8

(One should note the considerable permissible variation in these slumps and bear in mind that few recommendations as to concrete have any great degree of permanency. The foregoing is from the "Second Edition" of the booklet, "Revised and Enlarged, January, 1927." Later issues may advise changes in these figures.)

[2] W. W. Beach in "Specifications for a Hospital," York & Sawyer, Architects, The Pencil Points Press, Inc., 1927.

[3] See "Specifications for Plain and Reinforced Concrete, Water-cement Ratio Method, A.I.A. File 4b." Bulletin of the Portland Cement Association.

[4] From a "Symposium on the Behavior of Concrete," American Society for Testing Materials, 1923.

Fig. 11. Rodding the Concrete for Slump Test

Fig. 12. Measuring the Slump of the Concrete

secure a practically continuous flow during operation. Equipment shall be located as approved and shall be thoroughly cleaned after each run."

Separation of the ingredients is not likely to occur unless flowability has been induced by the addition of too much water in place of giving the spouting adequate incline. Such separation should be compensated for in the forms by the prompt addition of enough cement and sand to take up the surplus water. The mere fact of water coming in contact with unset concrete is not in itself harmful. The cement already in solution will not suffer, but it is most essential that it shall not be washed from the aggregate it is supposed to cover. Thus, concrete can be successfully deposited under water, provided that no current is permitted to pass against or through the mass and carry away any of the cementing element. This is effected by the use of special vessels (tremies) designed to dump the mix directly in its permanent position where it may be lightly tamped but not otherwise disturbed. Material so deposited should have a slightly excessive cement content to compensate for probable losses, and should be most accurately placed. It is not unusual for an entire job of the kind to be lost through some minor miscalculation.

(5-b) *The Newly Deposited Mix to be Adequately Agitated.* Whereas the density of concrete is dependent largely upon the proper grading of the ingredients, it is no less important that each atom, duly coated with liquid cement, shall rest in the closest possible juxtaposition to those surrounding it. As stipulated in the specifications:—

"DENSITY of all concrete shall be effected by thoroughly puddling, rodding, churning or otherwise agitating the wet mass to remove all air pockets and water holes and prevent honey combing of surfaces; but no concrete shall be agitated after the time limit specified."

This means elimination to the greatest possible degree of all air bubbles and water pockets, to avoid the possibility of there being cavities produced by evaporation. Agitation of the mix for this purpose is done by means of spading, rodding or churning the wet mix as soon as deposited, or by pressing an air hammer against the outside of the forms, or by tapping them with a hand hammer. "Honey combing" or pitting of surfaces is due to failure to surround the larger aggregates resting against the forms with fluid material,—strictly speaking, a defect in the agitation process. Except for mixes deposited under water and for dry mixes deposited on earth, the word "tamping" is no longer found in the best concrete specifications, since flowable mixes deposited in forms require tools other than the tamp. The initial set of Portland cement is assumed to begin about 30 minutes after it comes in contact with water; hence, under no circumstances, should it be disturbed in the slightest degree after that time. Contractors are likely to ignore this and have a way of asserting, with real confidence, that the "second set" of cement is as good as the first,—or practically so. There is no foundation for such belief, and hence the only safe course for the superintendent is to know that all cement is still fresh at the time of deposit and undisturbed after the 30-minute period. The custom in vogue by some mechanics of shoveling stale droppings back into the mix is to be deprecated. The saving attempted is not worth the chance being taken.

Habit is so strong with concrete workers that

it is sometimes found that gangs accustomed to paving and sidewalk work cannot be depended upon to follow specifications for reinforced construction. They persist in mixing too dry and in not sufficiently rodding the work, especially in deep forms. They are accustomed to following specifications which call for deposits in layers and tamped, which means rammed,—not rodded. Only recently have the better specifications ceased demanding that concrete in walls and similar masses shall be deposited in tamped layers from 8 to 12 inches thick. Such work is not monolithic, though that is the ideal condition at which we are aiming. When poured at considerable depth, therefore, as in column forms, the inspector must see that long, thin rods are vigorously used all around the reinforcing and other inserts and against the forms, but that such agitation shall not extend beyond the material just deposited. The same is true if compactness is sought by hammering the outside of the forms by hand or power hammers. The new, not the old, must be adequately attacked.

The dual importance of properly proportioning and mixing concrete and of correctly placing it implies, on work of any size, an omnipresence on the part of the inspector quite outside the sphere of human ability. One simply cannot watch the mixer and the place of deposit at the same time. This means that by the time the pouring is about to begin, the superintendent must have made up his mind as to the character of the contractor and his workmen,—whether or not they are to be counted upon to try to fulfill the specifications, or if attempted cheating is to be expected.

If in doubt, the architect should be notified and an opportunity given to have one or more additional inspectors assigned. The work of inspection starts well ahead of the pouring, as is evidenced by this specification paragraph:

"SUPERVISION. Before starting any pouring, the Superintendent shall be notified and given opportunity to inspect all surfaces which are to be covered and all members intended to be embedded. The Contractor shall also have a capable man (more, if needed), who shall watch the forms just ahead of pouring, see that all reinforcement and other built-in members are rigidly supported in proper position; all tags, chips and other refuse removed; all needed sleeves placed; all pipe and conduit ends plugged and all surfaces ready for the concrete. He shall strengthen all form supports as needed to prevent deflection or spreading.

"CLEANING FORMS. No concrete may be poured until all rubbish has been removed from the forms and they have been brushed clean and drenched just ahead of pouring (except in freezing weather) and the rubbish holes at bottoms of forms properly closed."

Thus are the duties of inspection at this juncture set forth in the specifications, with but one exception, which is treated of in the next section.

(5-d) *New Concrete to be Properly Bonded to Previous Work.* This is also covered in the specifications quite fully:

"CONSTRUCTION JOINTS. Each run of concrete shall be carried vigorously to completion. All temporary joints in walls or floors shall be at right angles to the run of work. Where reinforced floor work is stopped before an entire area is finished, joints shall be made in beams, joists and slabs under uniform load near middle of span. Where beams receive concentrated loads from connecting beams, the construction joint shall be located not less than twice the width of connecting beams from supporting beams. Beams having loads derived from a single connecting member shall have no construction joints. A 12-hour interval shall be allowed between the pouring of columns and that of beams and slabs. Construction joints in walls and piers shall be horizontal or vertical in all cases and shall not occur within 12 inches of a concentrated bearing. Dowels shall be constructed in all horizontal joints and continuous tongues in all vertical joints."

Then, under "Pouring",—

"UNFINISHED CONCRETE, against which new concrete is to be poured, shall first have the dowels removed, then be drenched and treated with thin grout or approved bonding cement."

It is customary to pour footings before wall forms are built, as a matter of convenience, whether or not they are of same ratios, and regardless of whether either is reinforced. Applying the paragraph on "Construction Joints" to those between footings and the superimposed walls, it is apparently necessary to lay dowels in the upper surface of the footing. For this purpose, it is customary to use vitrified brick or pieces of stone of about the same size or larger, laid half their depth in the wet flux at intervals of about 3 feet; or blocks of beveled plank, 2 x 6 x 18 to 30 inches, are pressed into the surface, to be removed when work is resumed. But, if a dampproofing layer is called for on top of the footings, as in the work of which we are writing, it is necessary that the dowel shall form a continuous beveled edge trench (as shown in Fig. 8), and hence planks must be prepared and laid in, to produce such a trench. Similar planks are set vertically in forms to make the tongues continuous.

It is obvious that the natural roughness of the aggregate in an unfinished surface is of assistance to the bonding of the new material laid against it, and yet the time such a surface may stand before being considered "old" and not amenable to bonding is not well established. There is no apparent reason for this other than that it is customary to continue a day's work anywhere that is found convenient on the job, regardless of the time when

the last concrete was poured in that locality. This is careless procedure, since it is evident that any concrete that has been quiescent for 30 minutes has taken its initial set and should not be disturbed or, if it has been in place for two or three hours, it will not readily amalgamate with new material. Therefore, the experienced superintendent will size up a day's work in advance and will see that each section poured is either complete in itself or is "bulkheaded off" with the construction joint members called for, so that they will be there when needed, regardless of whether the time lapse is one hour or 24. Workmen or their foreman, unless such procedure is insisted upon, will not ordinarily start setting construction joint members until the middle of the afternoon, apparently assuming that any concrete surface is "new" during the day on which it is poured. To this cause are to be attributed many "weepy" walls which, even though waterproofed, will transmit water along the lines of structural joinings.

(5-e) *Concrete to be Deposited Only Against Surfaces in Proper Condition to Receive it.* Not only must all surfaces of previous pourings be known to be in fit condition, but *all* surfaces of every character that the mixture will reach, including everything that is to be built in, must be inspected and passed upon. This is reiteration of the duties of inspection described in the preceding chapter, to which reference should be made. A good superintendent will, as soon as he finds the right man in the builder's crew, train him to inspect the work just ahead of pouring, as required by the specifications, and he must be able to depend upon him for such assistance. Once started right, a good concrete gang will coöperate with an apt superintendent; but, improperly managed, they may prove extremely difficult.

(5-f) *Concrete to be Properly Protected Until the Final Set is Complete.* The specifications on this subject read:

"PROTECTION. Concrete poured in warm weather shall be kept thoroughly wet after initial set and for 7 to 10 days or more thereafter dependent upon outside temperature. For all concreting carried on during freezing weather, such special precautions shall be taken as will obviate all danger of injury by frost. Only boiling water and heated aggregates shall be used. Frost shall be drawn from all surfaces with which fresh laid concrete is to come in contact, by blowing with live steam or drenching with boiling water, or both. An adequate enclosure, heated by continually fired salamanders, shall be maintained for the protection of work after pouring, and same shall also be covered, while fresh, with sand or straw and tarpaulins. No concrete may be poured, except by special permission, on days when the temperature at 9 a. m. is less than 25° above zero, Fahr."

The guarding of green concrete from dangers of undue heat or cold is of the utmost importance. Covering and moistening are correct preventives against the former, are easily attended to, and should be insisted upon as essential to proper curing. But protection against cold is much less simple, though no less necessary. "A. I. A. File 4c4" of the Portland Cement Association gives "Specifications for Making, Placing and Curing Concrete in Cold Weather" and also describes "Cold Weather Protection for Reinforced Concrete Works," particularly stressing the latter. These specifications are preceded by this warning: "Adequate protection of concrete against damage by frost during the making and early curing period is *absolutely essential* whenever temperatures below 40° Fahr. are likely to occur within that period. The use of a *definite and complete specification* governing such protection *is imperative* if real assurance of an undamaged and completely satisfactory structure is to be obtained." From a perusal of these specifications and directions, it can be readily understood that the carrying on of concrete operations in freezing weather is not a project to be lightly undertaken, —is not warranted, except in cases of extreme emergency and when the contractor is fully equipped for proper procedure. It is to be noted that the Portland Cement Association, in this publication, says that "the use of salts, chemicals or other foreign materials in the mix to lower the freezing point of the concrete is prohibited," but that "within certain limitations, calcium chloride or calcium oxychloride may be used in Portland cement mixtures to hasten hardening and to increase early strengths." But this whole subject of cold weather concreting is one for the attention of a superintendent of experience. He must needs be well versed in the specifications and protection methods described and have a working knowledge of their practical application. The less experienced inspector should have recourse to the paper just quoted and other authorities on the subject,—then wait for better weather, if possible to do so. If work must proceed, regardless of weather, he should see that *all* recommended precautions are taken, as no one can afford taking the chance of a failure of concrete construction.

Recapitulating, our superintendent on the schoolhouse project arranged to be notified just before the first concrete was deposited in the footing trenches in the southeast corner. He inspected the bottom, had some earth droppings removed, and ordered some loose earth above to be shoveled back, to prevent further droppings. He had previously made his final check of dimensions and approved them, after slight corrections. The mix for footings was specified to be 1:2½:5, with a 2-inch maximum aggregate, while that for base-

ment walls was to be 1:2:4, with a 1-inch maximum. Owing to this difference (and for general convenience), the contractor had two mixers on the job, one of fair size in connection with his stationary concrete plant, and a smaller portable mixer which he proposed using for the footings, for mortar and for other minor work. Thus, the concreting was started on the morning of Monday, April 23, just two weeks from the day ground was broken,—and they were still two days ahead of their schedule. Thereafter, for many days, the chief task of the superintendent was in watching the concreting, the formwork and the placing of reinforcement and other built-in members. The experienced inspector, knowing what factors to watch in the manufacture of his concrete, gives them his closest attention. Other materials are brought on the job ready-made, but, during the making of concrete, his building is transformed into a factory, the output of which is its own structural framework or some of its most essential parts. The ease with which some of the vital members of the building may prove defective is indicated by an extract from the report of a committee of the Detroit Engineering Society dated November 2, 1925:

"The character of structural concrete now being obtained in this city is a matter which is causing grave concern to all who are thoroughly informed regarding local conditions.

"Tests made from a number of the large local construction projects have indicated that concrete, as being produced, is, in general, very deficient in strength as compared with its strength assumed in the design calculations."

There is no good reason to suppose that conditions in Detroit were very different from those prevailing elsewhere in the country, or that they have since improved to the extent they should.

"Various reports and papers classify the causes of defective concrete and of failures. They are:

1. Poor cement.
2. Defective aggregate.
   (a) Stone not durable (as used in the Nashville bridge).
   (b) Aggregate not clean.
   (c) Presence of too much clay or organic matter.
3. Impure water.
4. Improper mixture.
   (a) Poor grading of aggregates.
   (b) Excess of water.
   (c) Insufficient mixing.
5. Poor workmanship.
   (a) Segregation.
   (b) Inaccuracy in proportioning and in controlling the quantity of water.
   (c) Carelessness in placing.
6. Improper curing.
7. Insufficient protection or heating in cold weather.
8. Removing forms too soon.
9. Poor design.
10. Shrinkage and expansion after set.
11. Corrosion of the metal.
12. Localized abnormal changes of temperature.
13. Action of alkalies or sea water, or trade wastes or sewage or atmospheric fumes.

This is a long list, and there may be other causes."[1]

Another writer on the subject[2] says that the reasons for poor concrete have been thus proportioned: "90 per cent from poor workmanship; 8 per cent from using poor aggregates; 2 per cent from using poor cement." He says that fine aggregates need very careful examination, and cites a case where concrete gave trouble because use was made of water from a stream affected by a factory using chemicals; another where disintegrating stone in a dirty car became mixed with broken stone otherwise all right; another where sand, otherwise usable, contained many grains injuriously coated. Verily, when dealing with concrete, no superintendent can be too alert.

[1] From "Steel for Strength and Security," by George F. Swain, Professor of Civil Engineering, Harvard University.

[2] R. S. Greenman, American Society for Testing Materials, 1914.

CHAPTER 10

THE SUPERVISION OF CONSTRUCTION OPERATIONS

CONCRETE REINFORCEMENTS AND OTHER BUILT-IN MEMBERS

AMONG the first materials to arrive at the school site were the steel bars intended to be used as concrete reinforcement. Since it is not possible for a superintendent to determine by inspection whether such bars are of the quality specified, the architect must be satisfied in this respect with what is supplied or must have recourse to laboratory tests or their equivalent; or, still another alternative, may specify a proprietary brand or brands of bars which he prefers.

Inasmuch as the variation in the quality of reinforcing bars on the market is not great, it is more economical for the designer to base his calculations on the poorest grade of material the market offers, using a commensurate factor of safety. On minor work, such procedure is probably warranted, rather than to subject the owner to the expense of employing an accredited testing laboratory. But on work of any importance, especially on public work such as the school build-

ing we have under consideration, it is common practice in the better offices to specify that such materials shall be tested. Such specifications may call for "new billet stock of structural grade" or "either re-rolled rail or new billet stock," in "rounds or squares" or "deformed bars of approved design and make," all to be "of full length required and accurately bent to details and meeting all requirements of the latest standard specifications for such materials as issued by the American Society for Testing Materials and subject to test (at Owner's expense) by a standard testing laboratory as directed by the Architect." Our school building specification further provided for use of a steel wire fabric of definite description in certain locations, and stipulated generally that "all reinforcing materials and inserts shall be free from paint, oil, dirt, scale or excessive rust." There were also the customary provisions as to the submission and approval of shop drawings, and a specification for placing reinforcement which stipulated, among other things, that it must "be correctly placed, rigidly wired together at each intersection with No. 18-gauge annealed wire, and carefully maintained in exact position and clearance, horizontally and vertically."

Operating under these specifications, the superintendent permitted the unloading and sorting of bars in the space allotted, pending receipt of advice regarding samples sent to the testing laboratory. The following day, he and the foreman received copies of schedules and bending diagrams, and men were at once set to work cutting and bending the members first needed. Bars are purchased by builders, either in accordance with diagrams and lists or in bulk quantities, to be formed on the site. Where bars are of simple shape and do not exceed 1 inch in diameter, there is supposed to be economy in the latter procedure. In either case, the superintendent must carefully check all sizes, shapes and quantities and see that the bars are properly sorted and stored under the direction of a man of sufficient intelligence and authority to prevent improper withdrawal at time of usage. In a location remote from a base of supplies, such as the site of the work we are discussing, the incorrect placing of any structural member in finished work implies a like misplacement of another and may be the cause of much annoyance and delay. This is to be particularly avoided in the case of reinforcement because of the crowding of concrete pourers on the heels of those placing the steel.

The first bars placed were in certain footings where they were supported up from the ground on small concrete blocks prepared for the purpose. The practice of using pieces of stone for this, or that of laying the bars on the ground and permitting the tampers to lift them slightly when concrete is poured is not sanctioned by good usage. Broken stones or pebbles tip easily, and hence are undependable for the purpose; nor should the bars rest upon the tops of small stakes as is sometimes done. Use of chairs, such as are commonly used in form work, is not practicable on soft earth, therefore the recourse to use of blocks of some sort. Bats of hard-burned common brick are permissible as chairs in footings, but in this case the superintendent had recently rejected the local brick, so he cautioned the foreman to have the pieces of concrete cast and in readiness, fearing possible delay in the receipt of better brick.

Since the design of reinforced concrete footings is based upon the location of tension members in certain relation to the encasing slab, it is incumbent upon the superintendent to see that such relationship is adhered to reasonably well. This, of course, applies throughout all reinforced work, but one finds workmen less careful with footings than when dealing with relatively smaller members. An instance of this is the case of an octagonal spread-footing, 18 feet in diameter, with 4-way reinforcement. A drawing of a section through the footing showed the first tier of bars 2 inches up from the bottom, and the others at successive intervals of 1½ inches above, making a total of 4½ inches between the centers of the first and top tiers. The architect witnessed the laying of the lower tier, then went to another part of the work. Returning a half hour later, he found that the tiers had been placed 6 inches apart, and hence the upper layer was close to the top of the 2-foot-thick slab. The foreman had failed to consult his drawings. When the concrete was promptly ordered out, he appealed to the contractor who, though a man of much experience and good repute, backed up his employe and made an issue of the matter. The work was on a cost-plus basis and, the architect standing by his decision, the owner decided in his own mind that he and the contractor were abused and stood the expense of making the correction. The architect didn't learn, until the owner employed someone else for his next project, that the contractor's contention that the architect was overly particular in matters of minor import caused the owner to believe that this was a foible that tended to make work emanating from his office unduly expensive. Of such slender threads is an architect's standing fabricated! Not only must he, as a superintendent, be most meticulous in discerning use of incorrect materials and placements, but he must anticipate such improprieties, catch them at their inception, if possible, in order to save time, expense and avoidable argument!

It is not unusual for a contractor to complain that an architect's supervision is too intermittent,—that it is not fair to the owner or builder to demand removal of materials, no matter how inferior or badly placed, discovered several days after installation. There is a certain degree of justice in this claim, and hence it is important that an architect, at the time of his employment, should make the point clear to the owner, explaining just what is to be expected as to number and frequency of visits under the terms of the contract; and that too extended intervals between inspections do not enable one to either check up the dishonest contractor or offer adequate assistance to one who is striving to do his best. The architect should urge upon the owner the need of the constant attention of a clerk-of-the-works at certain times during construction or under certain conditions that may be encountered on any construction work, and should reserve the privilege of assigning one (at the expense of the owner) at any time he thinks it advisable to so protect the owner's interests. Some architects, in order to avoid the waste of perfunctory visits at stated intervals, especially on out of town work of lesser importance, arrange their remuneration for supervision on a per-trip or per-diem basis. Then, if the work goes smoothly, the owner is spared all expense of unnecessary supervision.

In connection with the inspection of placement of reinforcing materials, too much stress cannot be laid upon the importance of knowing that every piece is in the exact location intended before pouring begins. Heavy rods are awkward members to handle, and slight inaccuracies in bending will tend to throw them well out of position. Chairs are easily neglected or displaced, wiring carelessly done and not always with the right kind of wire. A bar more than an inch out of place may not be subjected to the stresses computed for it or it may not receive the proper amount of protective covering. No doubt many expensive failures could have been traced to carelessness in such particulars. When one is supervising building a factory . . . engaged in the manufacture of artificial stone in monolithic form, one cannot well afford to permit the slightest detail of production operations to be slighted, but must bear in mind that the "personal equation" of each operative is bound to be reflected in the finished product.

Perhaps too little emphasis is ordinarily given to the considerable difference between supervising an ordinary lump-sum contract and one that is let on a cost-plus basis. In the case of the former, the inspector is concerned only in seeing that the owner gets what he is paying for, but with a cost-plus operation it is necessary also to know that the work is being economically handled as well as being honestly accounted for. Economical handling implies that each employe be suited to his task and produces as nearly to maximum capacity as can reasonably be expected. That there is much waste of labor in building is beyond question, some of it beyond prevention. In this, as in almost everything connected with construction procedure, all depends upon the foreman. And the greatest of labor waste can be found in slipshod concrete operations. An example of this was displayed by a gang of six men engaged with a mixer of small capacity. Two were wheeling the sand and gravel, two were wheeling the flux (four barrows to each charging), the "straw boss" was handling the cement and operating the mixer, and a college youth in rubber boots was agitating the flux in the forms. Having his eyes open, the latter suggested a change which was put into effect, whereby each charge was contained in two full barrow-loads, thus promptly releasing the mixer for recharging and speeding it up 100 per cent. Then the young man undertook to wheel and empty both barrows and do the small amount of necessary tamping as well, and releasing the two loafers who had been lazily wheeling half-full barrows. By the efficiency thus effected, the labor cost was reduced by one-third and the product doubled, turning it out at exactly 33 1-3 per cent of what it had been costing. This is an extreme case but an actual instance, and serves to show the need of watching labor action when one is paid to safeguard the owner's interest in it.

In addition to inspection of reinforcement placing, the superintendent must concern himself with each of the various members that should be in its correct position and there effectually secured before concrete is poured. He must be advised regarding all trades that will want to install members in or through concrete, ascertain that they have been duly notified, and see that such items are in place or that sleeves or boxes have been set to provide necessary holes for later installation and anchorage. Specification requirements as to who shall provide such sleeves and boxes and who shall place them vary in different offices, but they must, in any case, be most definite, or confusion and protest will result. Some architects stipulate that the concrete (or general) contractor shall provide all needed sleeves and boxes for such purposes and that the contractor for each interested trade shall "direct the placement" of all that are demanded for his work. Others say that each trade shall provide and install its own sleeves or shall provide the sleeves and oversee their placing in the forms. This last is probably the best practice, though the chief requisite is that there shall be no doubt or foundation for argument as to who is to do which.